

INFORMATION REPORT INFORMATION REPORT
CENTRAL INTELLIGENCE AGENCY

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COUNTRY USSR

REPORT

SUBJECT English Translation of MIG-21F-13
Aircraft Manual Entitled Technical
Description, Volume II, Armament

DATE DISTR. 26 June 1963

NO. PAGES 1

50X1-HUM

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1. English translation of the MIG-21F-13 /FISHBED E7
aircraft manual entitled Technical Description, Volume II, Armament 50X1-HUM
2. The book describes the K-13 /AA-27 missile system, the S-5M/S-5K unguided 57mm rockets, the tank pylon installations, gunnery system, ASP-5ND sight system with angle-of-attack and yaw sensor DUAS-8M, aircraft infrared viewer SIV-52, gun camera SSh-45-1-100-OS, seat ejection system, and the aircraft armor. 50X1-HUM

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INFORMATION REPORT INFORMATION REPORT

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AIRCRAFT

MiG - 21F - 13

TECHNICAL DESCRIPTION

Volume II

ARMAMENT

50X1-HUM

SECRET

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TECHNICAL DESCRIPTION

VOLUME II

A R M A M E N T

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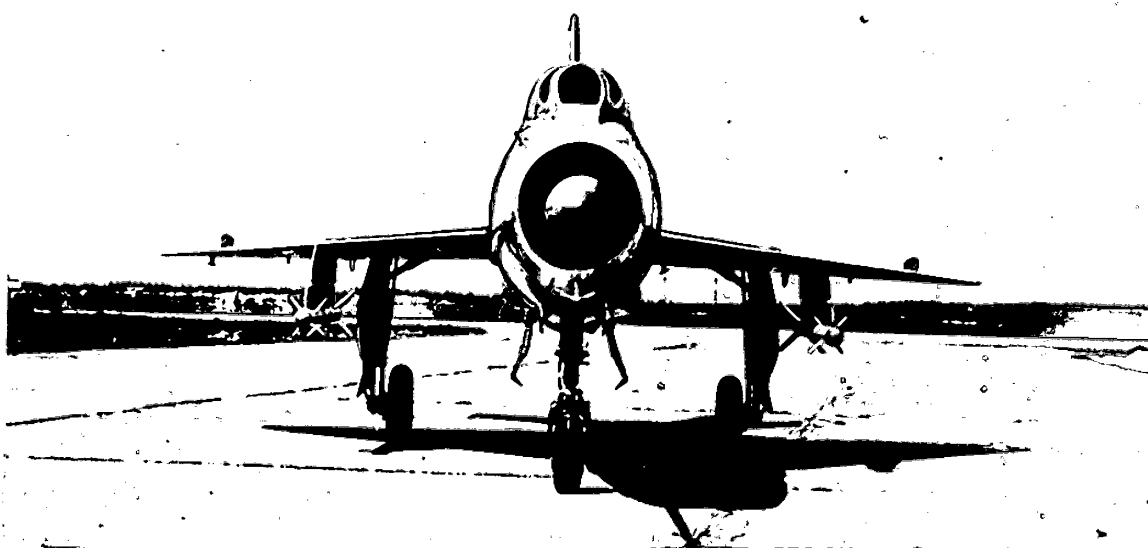
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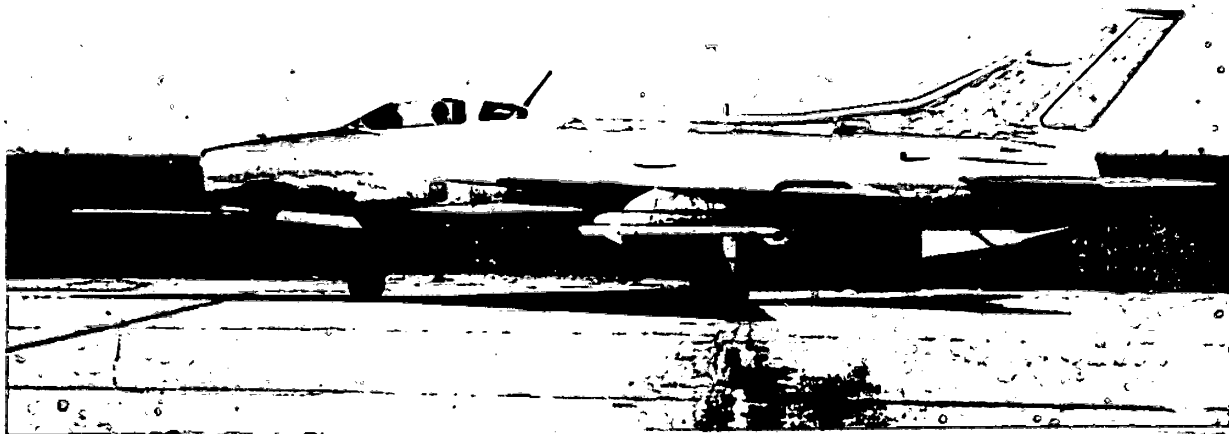


Сиг. 1. Самолет МиГ-21С-13, вид спереди.

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Секретно



Фиг. 2. Самолет МИГ-21А-13, вид сбоку.

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CHAPTER I

[p 4]

ARMAMENT GENERAL CHARACTERISTICS

Aircraft MIG-21F-13 (figures 1 and 2) is a single-seat fighter-interceptor possessing high performance and technical characteristics. Modern instruments, radio equipment, and sighting devices installed in the aircraft allow its employment in combat operations day or night, and under complex meteorological conditions.

Aircraft MIG-21F-13 carries missile armament (the K-13 system) as well as artillery; furthermore, pods of unguided rockets may be substituted for K-13 homing missiles.

A diagram of the aircraft armament arrangement is shown in Fig. 3.

The aircraft armament diagram used for training and adjustment of fire is shown in Fig. 4; shown are the side view and the front view. The sight collimating line and the longitudinal axes of all underwing carriers and the gun are inclined in relation to the fuselage reference line at an angle of $1^{\circ} 30'$.

On the horizontal plane, all types of the armament have a parallel fire adjustment sheaf.

1. MISSILE ARMAMENT INSTALLATIONS

[p 5]

Missile armament installations are designed in the nature of special exterior underwing attachments. For this purpose, underwing pylons BDZ-60-21U are installed on the wing beam, one on each side. The following variants of missile armament may be attached to the pylons, either directly or by means of launching mechanisms:

- two homing missiles K-13 of the "air-to-air" class (basic type: missile attached by means of launching mechanism APU-13);

- two pods UB-16-57U, each holding 16 unguided rockets S-5M or S-5K of 57 mm caliber (pods are attached directly).

Combat weapons representing the different variants of MiG-21F-13 armament are shown in Fig. 3.

Each pylon is equipped with a DZ-57 lock and sets of replaceable supports for installation of one or the other variant of armament.

Pylon lock mechanisms allow emergency release of either installation.

In case of an accidental drop of the installation from one of the pylons, the blocking mechanisms of the locks ensure emergency release at the

other pylon, and thus provide for simultaneous load release of both pylons. The pilot is made aware of ^{the} presence of the load on the pylons

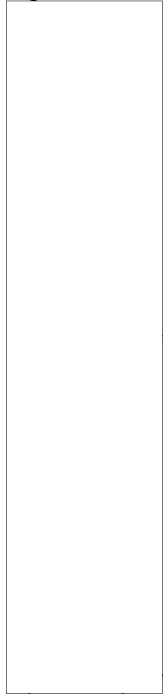
by two green signal lights ("Installation RS, APU"), located in the center [p 7]

panel of the instrument board, which go off when one of the following

is dropped:

- launching mechanisms APU-13 with K-13 missiles or without them;
- pods UB-16-57U with rockets, or without them.

The pylons have electric conductors and plugs for connection with the aircraft circuits on one side and with the launch mechanism circuits on the other. Access for connecting pylon plugs with the aircraft electric wiring (10-terminal and 30-terminal connectors in the wing) is provided through access holes in the top skin of the wing, located above the pylons.


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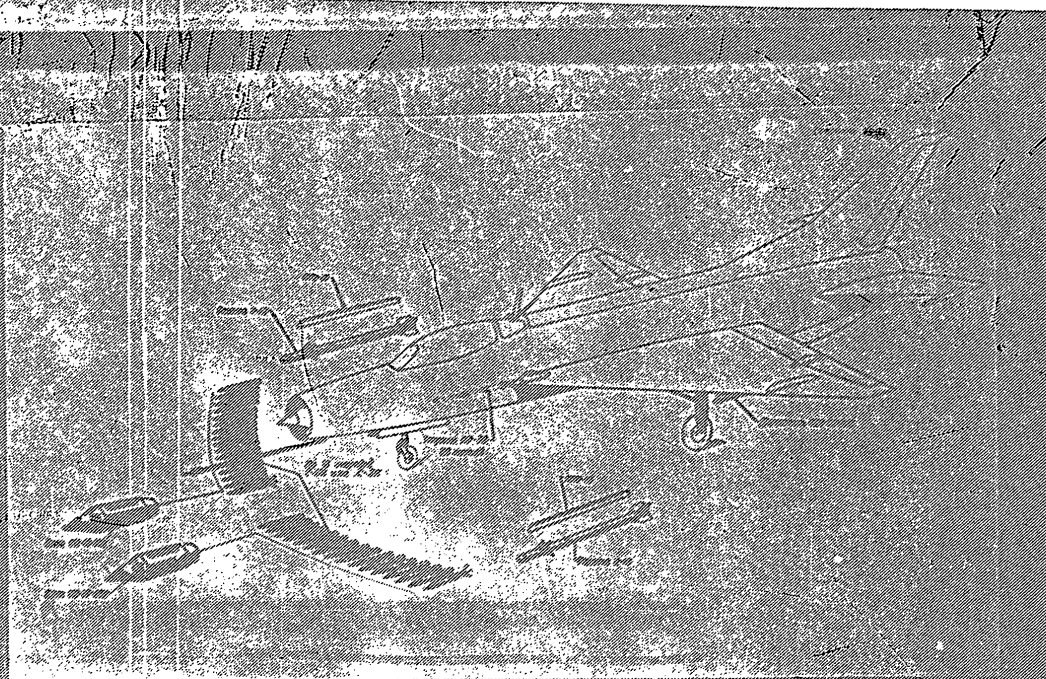


Fig. 3. Variant armament for aircraft MiG-21F-13

S-E-C-R-E-T

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On board the aircraft are missile and unguided rocket launching control equipment, control and signaling equipment, and appropriate electric circuits for launch preparation, for launching, or for dropping of any of the variants.

NOTE: In stencils located near control mechanisms, K-13 missiles are designated as "SS" and unguided rockets as "RS"

2. THE K-13 SYSTEM

The K-13 missile system represents a complex of combat and technical items, and includes:

- two K-13 homing missiles, "air-to-air" class;
- two underwing pylons BDZ-60-21U;
- two launching mechanisms APU-13, which provide for installation of missiles and the launching processes;
- equipment determining the launching range of K-13 missiles, including: range-only radar SRD-5MK, permissible range computer VRD-2A, air speed indicator DVS-5, and adjuster for ambient air temperature P-5;
- automatic gun sight ASP-5ND used in the K-13 system as collimating sight. The same sight is used for sighting when firing the cannon or unguided rockets;
- infrared viewer SIV-52 interlocked with the regular sight (for night sighting);
- overload indicator MP-28A;
- altitude signaling device VS-14500 which feeds an altitude signal to shift the overload value of the MP-28A overload indicator;

[p 8]

S-E-C-R-E-T

50X1-HUM

- control and signal instruments in the cockpit, and the airborne electric circuits which provide for electric power to the missiles on the pylons, giving out signals for missile launching, launching control, indication of the presence of missiles on pylons (and their separation from the latter), and signal light function checking.

The pilot is informed of presence of missiles on launching mechanisms AFU-13 by instrument board lights showing "Missiles Attached".

The operational principles of the K-13 system is as follows: [p 9]

The pilot, having detected the target, aims at it using sight ASN-5ND as a collimating sight (the sight's arrester handle is set in "Fixed" position).

The range-only radar locks-on the target and determines automatically the present range. Present range is checked by the pilot by reading range indicator UD-1 (see para. 4 "The Sighting Device")

The moment target range corresponding to the threshold sensitivity of the K-13 missile head is reached, target lock-on by the missile head takes place of which fact the pilot is informed by a change in tone and pitch of the sound signal received in his helmet set.

As soon as the present range and permissible range values (computed by the VRD-2A computer) become coincident, the "Permissible Range" light goes on.

Maximum permissible missile launch range is determined by the missile's ballistic capabilities and time of guided flight.

Missile launching is allowed at overloads not exceeding 2 at altitudes up to 14500 m., and not exceeding 1.6 at altitudes above 14500 m. Restriction of missile launching by overload is indicated by the

burning of signal light "Overload Signal" (above the instrument board).

Thus, launching of missiles is allowed only when there is change of tone of the sound signal in pilot's helmet set, the signal light "Permissible Range" is on, and there is no overload restriction.

Upon fulfillment of all the aforementioned conditions and performance [p 10] of the preparatory operations, (turning on the appropriate automatic breakers (AZS) and switches "SS Warming", "SS Filament", "SS Launch", and others), the pilot carries out missile launching by pressing the firing button on the handle of the aircraft control stick.

The missile launch control system is electrical and provides for launching of both missiles simultaneously or each missile separately, as well as for emergency salvo release. The following switches are used for this purpose: "SS Launch, Salvo-Single", "SS Launch, Left-Right; automatic breakers (AZS) "Emergency Drop - Tank, RS, AFU, SS Emergency Launch", placed in required positions beforehand; firing button and button "SS Emergency Launch", pressing of which produces the appropriate launching. In case of missile emergency launching, as well as in normal launching, the launching mechanisms remain attached to the pylons.

Key to Figure 4

Fig. 4. Aircraft Armament Schematic Drawing.

1. Front view of aircraft
2. SRD No. 1 unit training target
3. Target
4. Training device
5. Allowance for refraction of glass
6. Line of sight
7. Line of sight
8. Horizontal reference line
9. Middle lug axis
10. Pilot link trainer
11. Horizontal reference line
12. Frame #22
13. Frame # 28
14. Pilot link trainer axis (reflector geometr. axis)
15. No. 1 unit datum line
16. Frame #2
17. Fuselage datum line
18. Center of NR-30 front mount joint sphere
19. Horizontal reference line
20. Target diagram of cold training at 25 meters from the NR-30 muzzle face
21. Target diagram of cold training and live adjustment firing at 50 meters from the NR-30 muzzle face
22. Target diagram of cold training of SRD #1 unit at 10 meters from

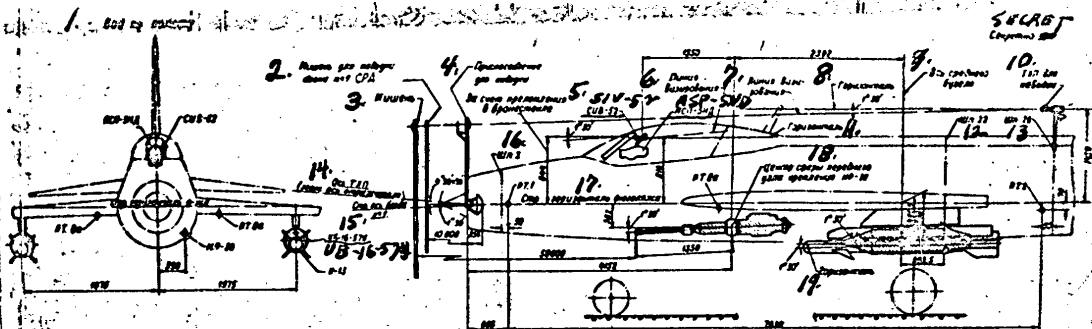
front edge of the fuselage

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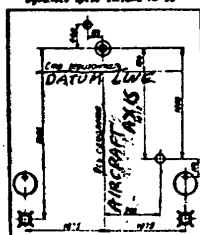
23. NR-30 cold training aiming point
24. ASP-5ND aiming point
25. Center of impact in NR-30 live adjustment fire
26. Aiming point of U5-16-57U (by the upper tunnel of the inside range)
27. Missile K-13 aiming point
28. Aiming point of the device
29. Points for checking adjustment of DES-2 with sight SIV-52
30. SRD unit #1 aiming point

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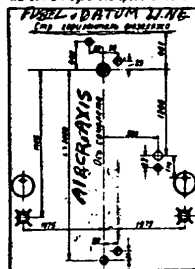
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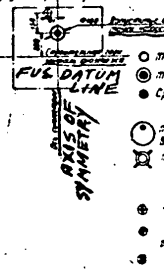
20. Схема системы для самолета на 25 м в дально-среднем секторе



21. Схема системы для самолета на 50 м в дально-среднем секторе



22. Схема системы для самолета на 100 м в дально-среднем секторе



AIMING POINT PERMISSIBLE DEVIAT.

- Точка наведения РП-30 при выстреле
- Точка наведения РП-54
- Точка наведения РП-54А
- Точка наведения РП-54Б
- Точка наведения РП-54В
- Точка наведения РП-54Г
- Точка наведения РП-54Д
- Точка наведения РП-54Е
- Точка наведения РП-54Ж
- Точка наведения РП-54И
- Точка наведения РП-54К
- Точка наведения РП-54Л
- Точка наведения РП-54М
- Точка наведения РП-54Н
- Точка наведения РП-54О
- Точка наведения РП-54П
- Точка наведения РП-54Р
- Точка наведения РП-54С
- Точка наведения РП-54Т
- Точка наведения РП-54У
- Точка наведения РП-54Ф
- Точка наведения РП-54Х
- Точка наведения РП-54Ц
- Точка наведения РП-54Ч
- Точка наведения РП-54Ш
- Точка наведения РП-54Щ
- Точка наведения РП-54Ъ
- Точка наведения РП-54Ы
- Точка наведения РП-54Ь
- Точка наведения РП-54Э
- Точка наведения РП-54Ю
- Точка наведения РП-54Я

Fig. 4. Aircraft armament schematic diagram

Reaching of the dangerous (minimum) range to the target is signalled by lighting-up of the light "Withdrawal from Attack". At this point the pilot must pull his aircraft out of the attack. If launching of the missile or missiles has not been accomplished prior to the moment the aircraft reaches the dangerous range, launching is forbidden since the aircraft may, in this case, be hit by fragments of its own launched missile.

Launching mechanisms APU-13 can be dropped from the aircraft with missiles as well as without them by pressing the emergency attachment drop button with the sign: "Emergency Drop RS, APU", located on the left side of the instrument board.

3. ARTILLERY ARMAMENT

[p 11]

The artillery armament of the aircraft consists of one caliber 30 mm aircraft cannon NR-30 installed in the lower forward part of the fuselage on the right side, with 60 rounds of ammunition.

The gun is attached by forward and rear mount fittings and the gun's barrel is supported by a third additional mount to reduce vibration. The muzzle end of the barrel is inside a gas compensator installed on the fuselage. The gas compensator provides for stability of the aircraft when the gun is fired by damping pitch and yaw moments created by the recoil as the result of the peripheral position of the gun relative to the longitudinal axis of the aircraft. The fuselage hatch where the gun is located is covered by barrel cowlings, speed brake and cover plates. Powder gases produced by the gun during firing are eliminated from the hatch into the atmosphere through a special gas port and lowers in the cowlings and inspection hatches. (see fig. 29).

Feeding of cartridges to the gun and ejection of links is accomplished by means of a closed system: the ends of the cartridge belt are linked together and when cartridges are extracted from the links by the gun feeder mechanism, the links stay hooked together and the belt does not come apart. The cartridge belt is placed in a rigid cartridge sleeve-guide (feed track) in the form of a ring, which occupies the space between the outer skin of the fuselage and the fuel tank compartment in a plane perpendicular to the aircraft's longitudinal axis. Links emptied during fire following the belt's movement enter the same sleeve-guide. Empty cartridge shells are ejected into the air. [p 13]

The reloading system is electro-pneumatic. It is done by means of compressed air and is controlled electrically by button. The reloading button is located on the left panel of the instrument board. The pilot is signalled that the cannon is ready to fire when the ready light on the center panel of the instrument board goes on.

The fire control system is electric. The fire control button is installed on the control stick of the aircraft. The same button is used also to launch K-13 homing missiles and unguided rockets.

4. SIGHTING DEVICE

Aimed firing of the gun and aimed launching of homing missiles and unguided rockets is accomplished by using sight ASP-5ND installed in the aircraft, which is interconnected electrically with the range-only radar, and optically with the infra-red viewer SIV-52. The latter is installed next to the sight head for target tracing and aiming at night in clear weather. The infra-red viewer can be easily removed and replaced by

camera SSh-45-1-100-08. This makes it possible to determine the accuracy [p 14] of practice sighting or check the result of firing by means of movie photography when firing the cannon or launching unguided rockets. In these cases pressing of the firing button also activates the SSh-45-1-100-08 with timing mechanism VM-2, which disconnects it a while later after the firing button has been released.

The range-only radar has two operating modes:

- mode "A" - with cannon and unguided rockets (electromagnetic energy is radiated by a broad radiation pattern antenna);
- mode "B" - with homing missiles K-13 (electromagnetic energy is radiated by a narrow pattern antenna).

The range-only radar operating mode is set by the mode switch marked "RS, cannon-SS", on the left panel.

The range-only radar locks in on the target and automatically determines the present target range. The pilot is informed of target lock-on when the "Lock-on" signal light installed on the sight head goes on.

In the "A" mode the range-only radar transmits the present target range to the sight, and it may be observed on the pointer dial located on the head of the sight; the operational range of the range-only radar against fighter-type targets in this case is at least 1400 meters. Upon closing in on the target to the pull out-from-attack range (600^{+50}_{-20} m), the pilot is given a signal by burning of signal light "Withdrawal" on the head of sight. ASP-5ND.

In the "B" mode, the range-only radar transmits the present target range to the comparator unit, and it can be observed on range pointer indicator UD-1 located on the bracket above the sight range indicator; in

this case the operational range of the range-only radar against a fighter-type target is at least 4500 meters; it increases 1.3 times against a medium bomber-type target, and 1.5 times against a heavy bomber-type target. Transmitted to the same comparator unit from the permissible range computer VRD-2A is the missile launching permissible range signal. When the permissible range is reached by the aircraft, ^{the} comparator unit becomes activated and sends a signal to signal light "Permission to launch missiles. The minimum range necessary for pull out from attack (1000 m) is signalled to the pilot by the burning of light "Withdrawal from Attack". Both lights are installed next to the range indicator.

Thus, in the "B" mode the sight is used as an ordinary collimating sight.

Sight ASP-5ND is also interlocked with the angle-of-attack and side-slip sensor DUAS-8M and ^S possesses a high degree of aiming accuracy in launching of unguided rockets, and good high-altitude capability (25000 m). The sight has a number of system selector switches installed on the support bracket of the sight head, allowing to select the type of armament to be used:

- armament type selector switch for firing or launching, "NR30-RS" [p 16] (position NR30 is used when firing the cannon and launching K-13 missiles; position RS - when launching unguided rockets);
- selector switch for operating on DUAS [incidence vane] or the altitude feed mechanism "N-DUAS";
- selector switch "S-B" which in this particular type of aircraft is used as on-off switch (position "S" is used only; position "B" is not connected)

Unit DUAS-8M installed in place of the regular Pilot-static head on its mount is ^{used} ^ to measure angles of attack and side-slip and feed these angles to sight ASP-5MD to ensure that the angle of lag is calculated as an angle of attack and side-slip function when unguided rockets (RS) are launched.

5. UNGUIDED ROCKET LAUNCHING CONTROL

The unguided rocket launching control system is electrical and in order to prevent accidental launching while the aircraft is parked on the ground, is ^{interlocked with} the front landing gear strut. Launching of rockets is possible only when the landing gear strut is fully retracted.

The control system for launching unguided rockets from pods UB-16-57U includes control mechanisms FUS-36D installed inside the wings above the pylons. Access to the FUS-36D is provided through access doors on the topside of each wing. The FUS-36D make it possible to launch rockets in a salvo (one rocket from each pod); in series of two salvos at .05 sec. [p 17] intervals between them (two rockets in each salvo) and in automatic series of salvos until all ammunition is used up, also at 0.05 sec. intervals. Operation of FUS-36D is controlled by the salvo switch on the left control panel. The initial launching is permitted only when the FUS-36D is in its initial position which is indicated by the burning of two signal lights "RS Position Zero" located on the right electric panel.

Launching of rockets is accomplished by pressing the button on the aircraft control stick handle.

Emergency drop of the pods UB-16-57U either with or without ammunition is accomplished by pressing the carrier emergency drop button with the sign "Emergency Drop RS, APU-SS",

Arrangement of the armament equipment control elements in the cockpit of the aircraft is shown in Fig 13.

NOTE: Technical data and other parameters on assembled units are cited in the description according to the materials supplied by manufacturers of the respective units.

CHAPTER II

THE K-13 SYSTEM

The K-13 missile system (Fig. 5) is a complex of combat and technical items including: [p 18]

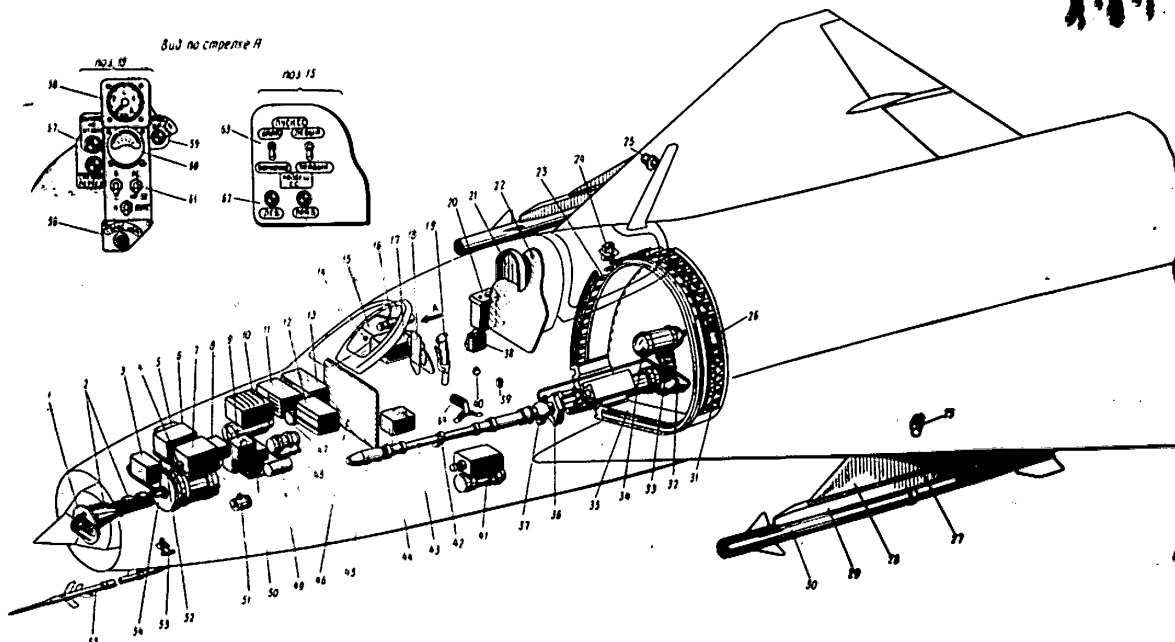
- two homing K-13 (30) missiles of the "air-to-air" class;
- two BDZ-60-21U underwing pylons (28)
- two APU-13 launching mechanisms (29) which serve to carry and launch the missiles;
- equipment for determining missile K-13 launching range, including: range-only radar SRD-5MK, permissible range computer VRD-2A, air speed indicator DVS-5, and ambient air temperature adjuster P-5;

Key to Figure 5

1 - combined broad- and narrow-beam antenna of range-only radar; 2 - waveguide channel; 3 - null gyroscope of ASP-6ND sight; 4 - SRD control plug; 5 - SRD control panel; 6 - SRD ranging unit; 7 - SRD power supply; 8 - SRD comparator unit; 9 - computer for ASP-6ND sight; 10 - PO-500A converter; 11 - null gyroscope of sight; 12 - sight control box; 13 - electronic relay unit of sight; 14 - K-13 missile emergency launch button; 15 - upper right panel of instrument board; 16 - instrument for observing infra-red viewer SIV-52; 17 - sight head ASP-5ND; 18 - bracket and panel with sight selector switches; 19 - firing and launch control button and sight damping button on aircraft control handle; 20 - power supply for SIV-52 viewer; 21 - armored head protector of seat; 22 - back protection armor; 23 - ammunition belt; 24 - overload indicator MP-28A; 25 - control mechanism PUS-36D for unguided rocket launching; 26 - ammunition belt coupling; 27 - adapter beam; 28 - wing pylon BDZ-60-21U; 29 - APU-13 launching mechanism; 30 - K-13 missile; 31 - ammunition belt links; 32 - electro-pneumatic valve EK-48; 33 - rear gun mount fitting; 34 - compressed air tank (1.8 liters); 35 - ammunition belt guides; 36 - front gun mount fitting; 37 - gas outlet; 38 - filter F-14A in sight power supply circuit; 39 - mode switch for range-only radar and missile launching and firing circuits with sign "RS, Pushka-SS" (Rockets, Gun-Missiles); 40 - loudness control for K-13 missile audio signal; 41 - PO-750A converter; 42 - mount for auxiliary fitting of gun barrel; 43 - NR-30 gun; 44 - voltage stabilizer of ASP-5ND sight; 45 - gas compensator; 46 - forward armor plate; 47 - altitude mechanism of ASP-5ND sight; 48 - permissible range computer VRD-2A;

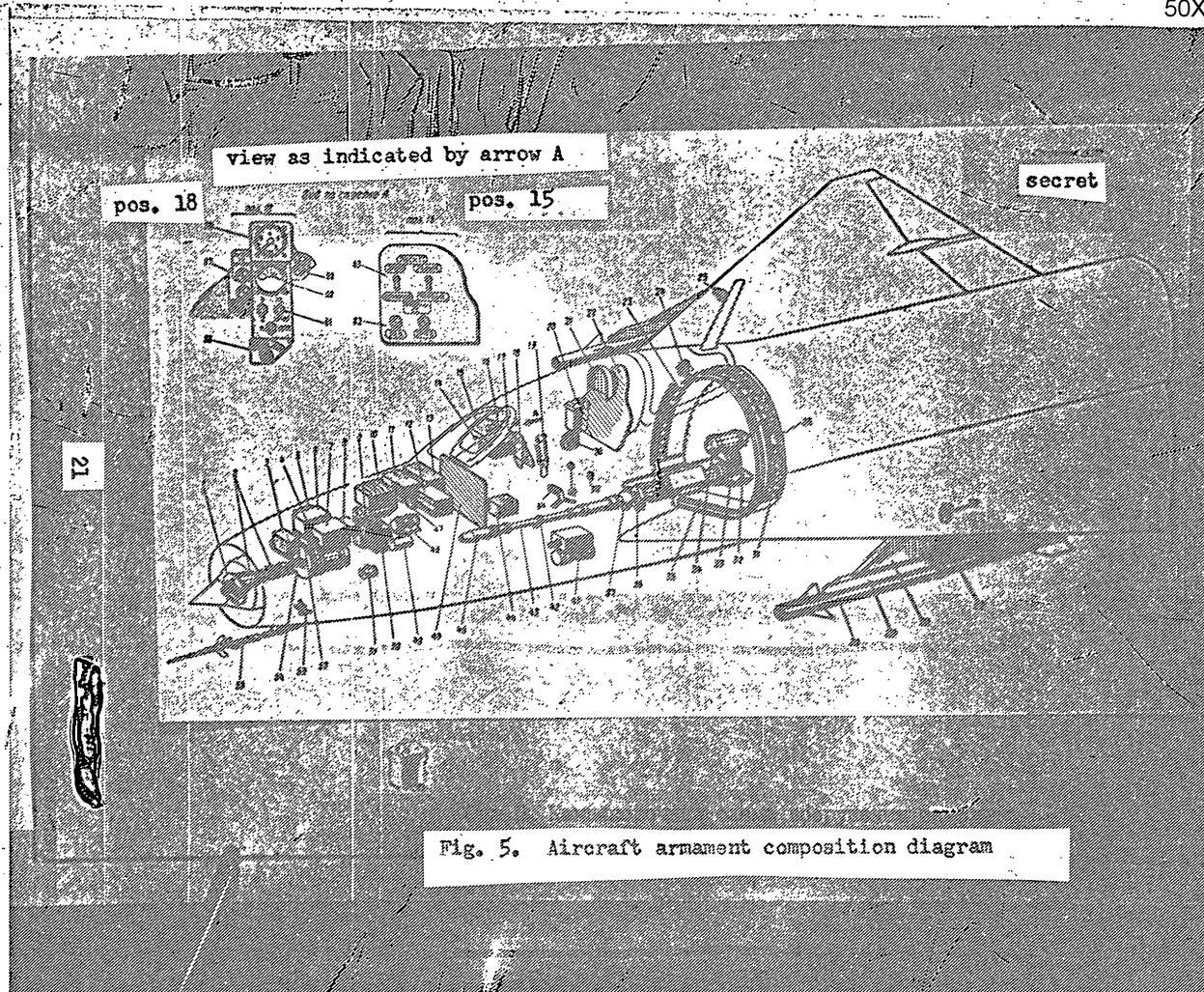
49 - air speed indicator DVS-5; 50 - PY-500Ts converter; 51 - altitude signalling device VS-14500; 52 - speed unit of range-only radar; 53 - temperature receiver P-5; 54 - range-only radar transceiver; 55 - angle-of-attack and sideslip indicator DUAS-8M; 56 - target clearing button; 57 - signal lights for overload and withdrawal from attack of K-13 system; 58 - range indicator UD-1; 59 - signal light for permissible launching range of K-13 missile; 60 - range indicator of ASP-5ND sight; 61 - sight mode switch; 62 - signal lights indicating presence of K-13 missiles on pylons; 63 - K-13 missile launch control switch; 64 - potentiometer for manual introduction of range to sight.

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50X1-HUM



Фиг. 5. Компонентная схема вооружения самолета

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- aerial sight ASP-5ND interconnected with the range-only radar.
When used in the K-13 system for launching missiles, the sight is used as a collimating viewer (see chapter VI);
- infra-red viewer SIV-52 interconnected with the sight (used for night sighting);
- overload data unit MP-28A which actuates the overload signal;
or 1.6 at altitudes over 14500 m.,
When overloads exceed 2 at altitudes up to 14500 m., the overload data unit actuates signal light "Overload Signal"; launching of missiles in this case is not permissible;

[Figure 5]

- altitude signalling device VS-14500 which sends altitude signals [p 22] to the overload value change-over relay of the MP-28A unit;
- control and signalling equipment in the cockpit, and the airborne electric circuits which provide power for the missiles on their carriers, missile launching signalling system, launching control system, signalling the presence of missiles on (and their separation from) launchers, and signal light function checking.

1. HOMING MISSILE K-13

Purpose

K-13 homing missile belongs to the "air-to-air" class of homing missiles and is intended for striking aerial targets during day and night under ordinary meteorological conditions, within the entire operational speed range and at all flight altitudes of the MiG-21F-13 aircraft.

DESIGN

The missile has a homing head, control surfaces, and contact and proximity fuses. The missile is built in accordance with the "UTKA"

aerodynamic design, with control surfaces and wings arranged in the same mutually perpendicular planes. In relation to the axes of the launch aircraft, i.e. when suspended underwing, the control surfaces and wings form an "X".

[p 23]

The missile body (Fig. 6) is cylindrical, made of metal, and has a hemispherical nose. Structurally, the missile is made up of five adjoining compartments, or in regard to interchangeability - four, as the first and second compartments cease to be interchangeable after adjustment, and become one single compartment.

The first compartment (1) houses the homing head and its electronic unit. The signal sent by the head via magnetic amplifier of the electronic means is transmitted to the control surface mechanisms in the second compartment.

In the second compartment (2) are located two pairs of control surface mechanisms, solid-reactant gas generator (PAD) with a distributing plate, turbo-generator, and thermoregulator. On the outside of the compartment are located four steel control surfaces (6) of triangular shape, activated by the control surface mechanisms. A plug connector SR-20 is located between the control surfaces and connects the missile circuits with the airborne circuits through launching mechanism APU-13.

The third compartment (3) is a directed fragmentation warhead.

The fourth compartment (4) contains the proximity fuse which becomes activated when the missile passes near the target.

The fifth compartment (5) is a powder rocket motor (PRD-80) which provides thrust. Powder gases flow out of the centrally located nozzle, surrounded by a ring tracer.

The motor ensures movement of the missile at the speed necessary [p 24] for overtaking the target. The body of the powder propellant rocket motor represents the prime power unit of the missile.

The three guides (7, 8, and 9) located on the body of the fifth section are used to suspend the missile from the guide of launching mechanism APU-13 from which it slides off in launching. Forward guide (7) has two contacts installed in it, one connecting the firing cartridge circuits of the powder propellant igniter; the other connecting the firing cartridge circuits of the missile fuse-batterywarming grain. Middle guide (8) is attached to the rocket motor case by means of a collar and can be moved when necessary. Rear guide (9) is stationary.

Four trapezoidal fins (10) are attached to the rear part of the motor case. They are mutually perpendicular in the same planes as the control surfaces.

To provide lateral stability to the missile in flight, gyroscopic drift stabilizers-rollerons (11) are installed on wing tips. Prior to launching each rolleron is locked by means of spring-locking pin mechanisms; when the rocket motor is started, the mechanisms are actuated and the rollerons unlocked at the time the missile is launched.

When an angular velocity of rotation develop around the rockets' longitudinal axis, each rolleron precesses like a gyroscope, is deflected and produces a moment which counteracts the rocket's rotation around its longitudinal axis.

2. WING PYLON BDZ-60-21U

[p 26]

The pylons (2 pcs.) are symmetrically located under the left and right wing cantilevers distance of 1975 mm from the plane of symmetry of the aircraft (see fig. 4).

Purpose

Pylon BDZ-60-21U is intended for simultaneous suspension under the wing of only one of the following items:

- one missile K-13 (by means of launching mechanism APU-13);
- one launch pod UB-16-57U holding 16 unguided rockets S-5M or S-5K.

Basic technical data

Weight of the pylon including attached:

- K-13 missile 21.5+1 kg.
- unguided rockets 22.5+1 kg.

Dimensions:

- length 1494 mm.
- width 62 mm.

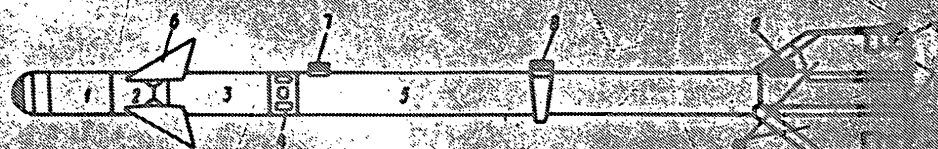
Method of signalling presence of attached load. Electric lamp

Type of fastening to aircraft wing. Pin

Pylon adjustment angles

- vertical $\pm 30'$
- horizontal $\pm 25'$

[p 27]



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Secret

Fig. 6. Missile K-13 homing guidance package diagram

1-homing head; 2-control surfaces mechanism hatch; 3-operational unit;
4-proximity fuse; 5-powder-propellant missile engine; 6-control surfaces;
7-front guide; 8-middle guide; 9-rear guide; 10-wings; 11-rollerons;
12-stop pins.

S-E-C-R-E-T

Design

Pylon BDZ-60-21U (Fig. 7) is^a cast aluminum alloy beam (14) of rectangular cross section with internal transverse and longitudinal stiffening ribs, covered at both ends with cowls (3) and (21).

The contour of the pylon's upper side corresponds to the contour of the lower surface of the wing; a rubber gasket (4) is installed between them for tighter fit.

Front and rear attachment taper bolts (9) and (16) are installed by means of special pins (10) and (20) in the upper bosses of the beam.

When installing the pylon, these bolts are fitted into special wing fittings (8) and (17) with release bushing rings (5) and (15) with conical openings. When nuts (6) and (18) are screwed on to the cylindrical threaded portion of the taper bolts and tightened, the beam is pressed against the wing, and the release rings ensure a tight and snug fit.

The rear taper bolt has an oval hole in it for special pin (20) which helps to avoid error in installing the pylon on the wing along axis "X".

Inside the pylon are located: type DZ-57 lock (13) for load attachment; front (39) and rear (31) supports for transmission of forces from the launching mechanisms to the pylon and for adjustment of launching mechanism position; plug connectors (11), (12), and (36); and electrical conductors.

The pylon has openings in its side walls for locking and mechanical release of the lock by hand, and for lock lever position control.

[p 28]

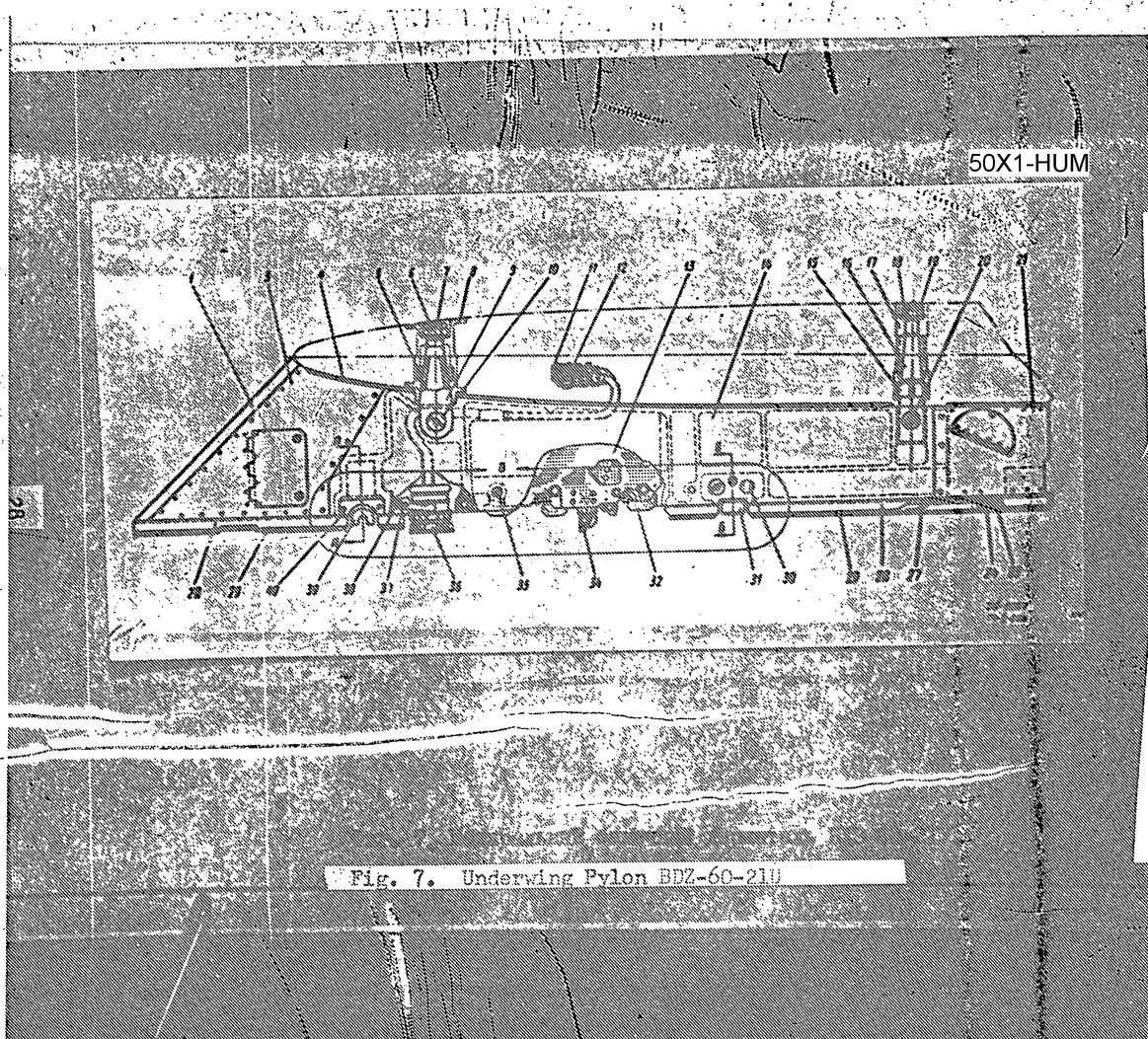


Fig 7. Wing Pylon BDZ-60-21U

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1 - Knife like front section; 3 - forward fairing; 4 - rubber gasket; 5 - release bushing ring; 6 - nut; 7 - lock nut; 8 - forward wing joint; 9 - tapered bolt of forward wing mounting; 10 - pin; 11 - plug connector SHR56PK3ONG1; 13 - lock DZ-57; 14 - pylon frame (beam); 15 - release bushing ring; 16 - tapered bolt of rear wing mounting; 17 - aft wing joint; 18 - nut; 19 - lock nut; 20 - pin; 21 - fairing; 23 - peg; 24 - telescopic assembly; 27 - leaf spring; 28 - adapter beam (stationary portion); 29 - adapter beam (with spring bottom); 30 - rear support adjustment pin; 31 - rear support; 32 - lock DZ-57 carrying levers; 34 - load suspension locking and signalling rod; 35 - lock attachment pin; 36 - plug connector 2RM42KPN30G2V1; 37 - lever; 38 - spring; 39 - forward support; 40 - access to adjustable bushing of forward support.

Near the opening for locking of the lock (on the right side) are located the sign "lock" and an arrow indicating the direction in which the key must be turned when locking the lock. Near the opening for mechanical release (on the left side) are located the sign "release" and an arrow indicating the direction in which to turn the key for mechanical release of the lock.

To eliminate the gap which forms between the pylon and the launching mechanism AFU-13 (or unit UB-16-57U), a light adapter beam is attached to the lower surface of the pylon, which has a stationary part (28) attached to the beam by screws and a movable bottom (29) attached to the stationary part by a series of telescopic assemblies (24). The movable bottom of the adapter beam is pressed downward by the force of a number of leaf springs (27) placed between the fixed part and the bottom. The movement of the movable bottom is controlled by pegs (23) placed in slots of the telescopic assemblies. The adapter beam is made up of three separate parts: front, middle, and rear.

Pylon Electrical System

Connection of the pylon circuits with the airborne circuits is accomplished by means of two plug connectors: 10 - terminal connector (12) connecting lock DZ-57 circuits, and 30 - terminal connector (11) connecting the launching mechanism circuits. Plug connectors (11) and (12) pass through an opening in the wing where they are plugged into sockets of the airborne circuit, (Access to the plugs and to the nuts of the tapered bolts is provided by three access holes located on the upper surface of the wing).

[p 29]

Connection of launching mechanism AFU-13 or unit UB-16-57U circuits

with the pylon circuits is accomplished by means of a small 30 - pin terminal (36) the 2RM42KPN30G2VI type (socket). This connector is pressed down by a fork-like lever (37) with a spring (38), thus ensuring tight connection with the female plug on the launching mechanism. In order to disconnect the circuits, the male plug of the pylon is pulled out of the launching mechanism's female plug by turning a lever (37) with a key, using the square end of the key. The key turning directions are indicated by arrows with signs: "disconnect" and "connect" inscribed on the pylon.

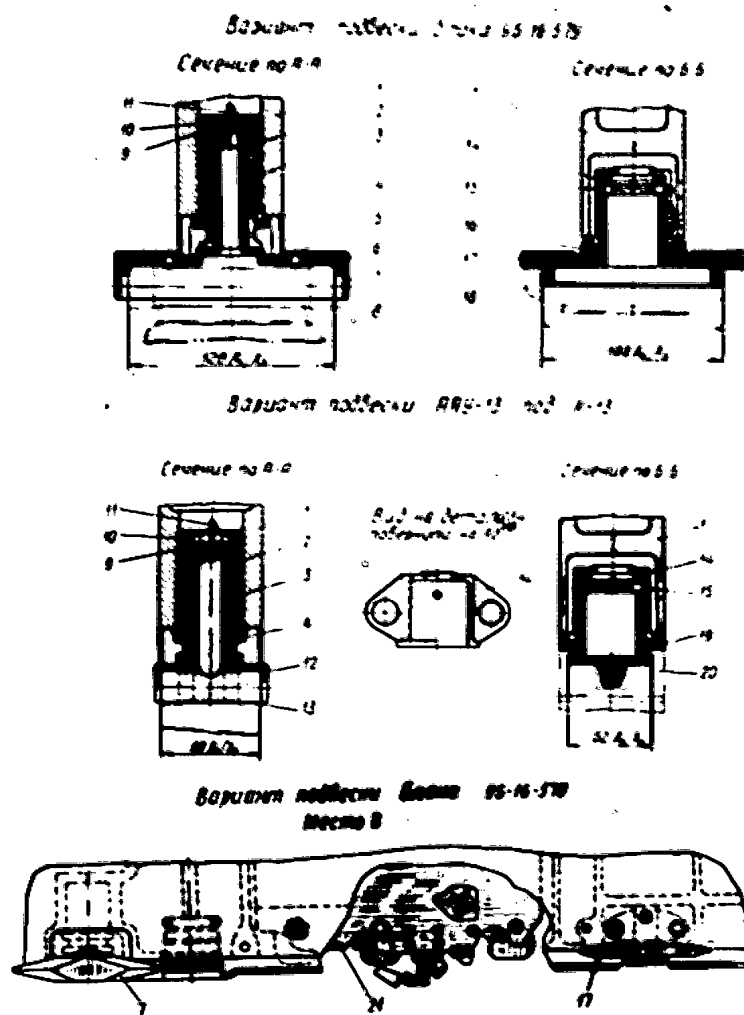
Pylon Supports

In order to make it possible to attach launching mechanisms with different support fittings, the pylon is provided with two pairs of supports (fig. 8).

The forward support of the first pair has a 60 mm base, and the aft -- a 52 mm base. This pair is used for attaching APU-13 launching mechanism with a K-13 missile to the pylon.

In the second pair, the forward support has a 120 mm base, and the aft -- a 108 mm base. This pair is used for attaching launch pod UB-16-57U. (see page 25 for detailed description of BBZ-60-21U underwing beam carrier shown in fig. 7)

The forward support (6 or 12, fig. 8) is designed in the form of a clamp with a round smooth pin holding the corresponding support of either unit UB-16-57U or launching mechanism APU-13. The support pin is inserted into the adjustment bushing (3) and is secured by a nut (10) and cotter pin (11) after taking up the slack. The assembled support is screwed into a fastening bushing (2) which in turn is screwed tightly into the pylon body. [p 32]

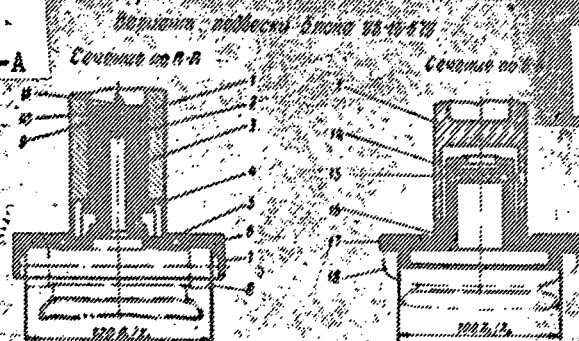


Фиг. 8. Упоры двигателя БВЗ-60-21У для разных вариантов полвески (место В и сечения А-А, Б-Б из фиг. 7).

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Variant of unit UB-16-57U attachment.

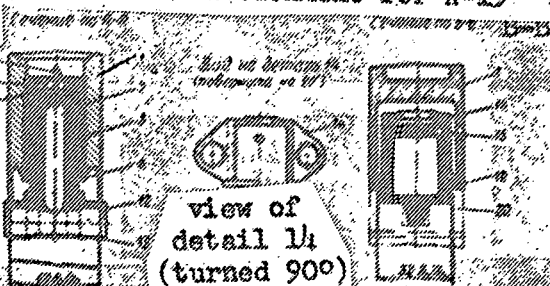
cross
section A-A



cross section
B-B

Variant of APU-13 attachment for K-13

cross section
A-A



cross section
B-B

Variant of unit
UB-16-57U attachment
Place "v"



Fig. 8. Carrier BDZ-60-21U supports for various types of attachments (place "v" and cross sections A-A and B-B from Fig. 7)

Fig. 8. Pylon BDZ-60-21U supports for various types of attachments (place "V" and cross-sections A-A and B-B are from fig. 7)

1- Pylon housing; 2 - attachment bushing; 3 - adjustment bushing; 4 - lock nut; 5 - screw; 6 - forward support with 120 mm base; 7 - cover plate - fairing; 8 - matching forward support of unit UB-16-57U; 9 - washer; 10 - nut; 11 - cotter pin; 12 - forward support with 60 mm base; 13 - matching forward support of APU-13; 14 - attachment and adjusting socket; 15 - spring locator; 16 - rear support with 108 mm base; 17 - cover plate - fairing; 18 - matching rear support of unit UB-16-57U; 19 - rear support with 52 mm base; 20 matching rear support of APU-13; 21 - lock DZ-57.

The support is raised or lowered by turning the adjustment bushing with a special key which fits into the slots in the bushing's head (in the thread and around the pin). Upon completion of vertical adjustment of the support, the adjustment bushing must be secured by a lock nut (4).

This type of support assembly allows quick replacement of support (6) with a 120 mm base by support (12) with a 60 mm base (when substituting the APU-13 mechanism for UB-16-57Upod) or vice-versa without disturbing the adjustments. In order to do this, it is necessary to remove the forward cowl, cutter pin (11), unscrew nut (10) from the support pin, remove the support, and replace it with one with a different base, and then secure it using the aforementioned operation in reverse.

In this way the forward support presents any longitudinal or lateral shifting of the suspended launching mechanism (or pod), and allows vertical adjustment of APU-13 (or the pod) within the limits of $\pm 0^{\circ}30'$.

(see fig. 8 and description - pages 32 and 33).

[p 35] The aft support (16 or 19, fig. 8) is designed in the form of a rectangular platform with support base surfaces matching those of the attachment support and a cylindrical socket in which a spring lock pin (15) is located diametrically.

The support socket is placed in the hollow cylinder (14) of the support assembly and is locked in by the spring pin which snaps into a hole in the cylinder. Cylinder (14) has two pairs of lugs by which it hangs on bolts which pass through the pylon walls. One fastening bolt is plain, while the other (30, fig. 7) is threaded. One of the cylinder lugs also is threaded (fig. 8, view in detail 14). By turning the bolt (30, fig. 7) the cylinder may be shifted right or left together with the support attached to it. In this way the aft support prevents lateral shifting of the attachment and allows horizontal adjustment of the launching mechanism (or pod) position within the limits of $\pm 0.025'$.

To replace the rear support that has a 108 mm base with a support that has a 52 mm base (when replacing a UB-16-57U pod with a APU-13 launcher, it is necessary to reach through the access in the pylon wall, press the spring lock pin of the support, remove the support, and replace it with the other one; the latter will lock itself in the same manner.

DZ-57 Lock

The lock is fixed in the pylon wing by means of three bolts passing through the hollow axes of the carrying arms.

Purpose

[p 36]

Lock DZ-57 (fig. 9, 10) is intended for attachment and release of aviation launching mechanisms APU-13 and pods UB-16-57U (loaded or unloaded).

Basic technical data

Release controlelectrical, from the aircraft power network

Operating voltage.....27^{+10%} v.

Minimum operating voltage.....20 v.

Current required for emergency operation at 24 v. and temperature of +20°C.....6.9a.

Operational temperature range.....+50°C to -60°C

Load presence signalling system.....electrical from the MBS network

Number of operations:

armed.....700

unarmed.....1400

Overall dimensions:

length..... 322 mm.

width..... 33 mm.

height..... 220 mm.

weight..... 3.4 kg.

Construction and interaction of lock parts.

[p 37]

The lock consists of a housing (14) made of stainless steel in the form of a $\sqcap$ (inverted English U) channel in which are installed: three carrying arms (15, 25, 29) for load attachment; stop (11, 8) and other levers of the mechanism; trigger spring (4); electromagnetic trigger mechanism (16, 17); MBS locking and signalling mechanism (22, 24); and

electric wiring. A male and female plug are attached to the housing to connect the lock circuit with the aircraft's electrical network.

The carrying arms are connected with each other by links (2, 13). The load is attached to the carrying arms by lugs (30). The lug is locked by support (29) while spring (28) presses the toe of the support against the lug. The carrying arms are kept in a locked state by stop lever (11) which, by means of connecting link (10) and small stop lever (8), transmits the force on to platform "a" of the cocking lever (7). The cocking lever is interconnected through its pivot with lever (18) which in turn rests against platform "S" of trigger lever (17), held back by the tension of spring (20). Inspection holes for checking lever connections are located at points "A", "S", and "U" in the lock and pylon walls.

The lock is placed in "closed" position in the following manner: turn the carrying arms by hand in the direction of the flight and, while holding them in this position, cock the lock mechanism by turning the cocking shaft (6) with a key along the direction of the arrow which reads "cocking". At this point cocking lever (7) fixed on the cocking shaft makes the rod (5) connected with it shift, thus compressing (cocking) trigger spring (4), while its platform "V" goes under the end of the small stop lever (8). At the same time, the other end of the cocking lever turns intermediate lever (18) by means of a shaft which is inserted in a slot of lever (18), engaging the latter with the cocking lever (17) of the electromagnetic release mechanism.

[p 38]

Trigger spring travel equals 7.5 mm. Locking area "S" is at least 2.5mm.

Load release control is electrical and is accomplished by means of the electromagnetic release mechanism of the lock.

The electromagnetic release mechanism consists of a rotary type electromagnet (16); trigger lever (17) fixed to the shaft of the electromagnet armature; and spring (20), which restores the armature to its initial position after actuation. Actuation voltage is $27 \pm 10\%$ v. The armature's initial rotating moment (when the trigger lever turns $11^\circ \pm 1^\circ$) equals 3.5 kg cm. The magnet coil has two windings, one of which is used for emergency release (shown by heavy line in fig. 9).

When electric current is fed to the coil of the magnet, the latter's armature turns, trigger lever (17) disengages from intermediate lever (18), and the lever system is subjected to the effect of the tension of spring (4).

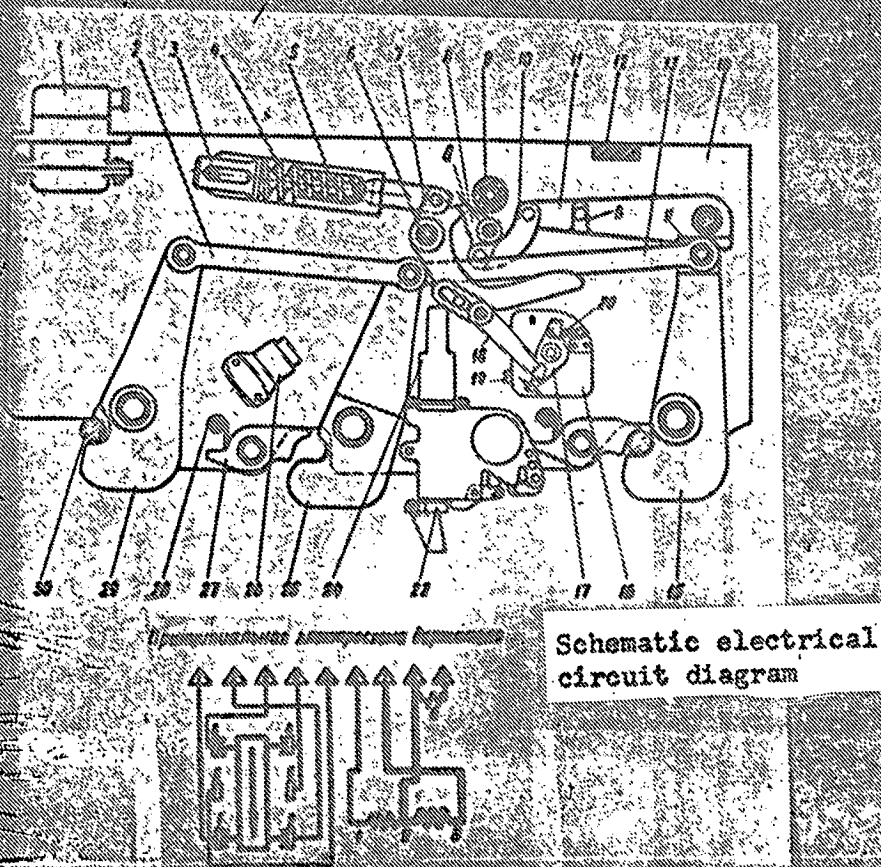


Fig. 9. Lock DZ-57 and Schematic Electrical Circuit Diagram. Position "Closed"

Fig. 9. Lock DZ-57 and Schematic Electrical Circuit**Diagram Position "Closed"**

1 - plug and socket; 2 - front push-pull rod; 3 - drum; 4 - trigger spring;
5 - trigger spring rod; 6 - cocking axis; 7 - cocking lever; 8 - small
stop lever; 9 - vibration absorber; 10 - connecting link; 11 - stop lever;
12 - vibration absorber; 13 - back push-pull rod; 14 - body; 15 - back
carrying arm; 16 - trigger mechanism electromagnet; 17 - trigger lever;
18 - intermediate lever; 19 - adjustment screw of armature shift angle of
the electromagnetic release mechanism; 20 - trigger lever retracting spring;
22 - cap of locking and signalling mechanism rod; 24 - body with fixed contacts
of locking and signalling mechanism; 25 - middle carrying arm; 26 - vibra-
tion absorber; 27 - stop; 28 - stop spring; 29 - front carrying arm;
30 - ring of suspended load.

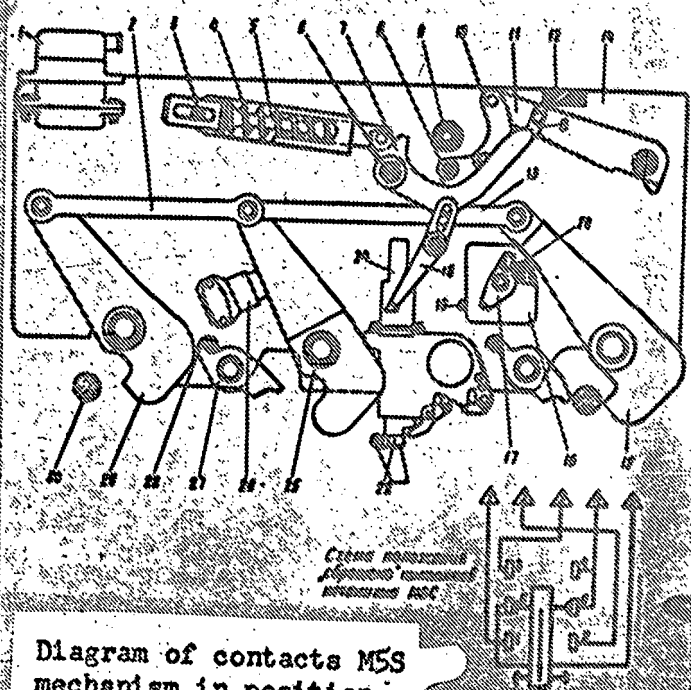


Diagram of contacts M5S
mechanism in position
"Closed"

Fig. 10. Lock DZ-57. Position "Closed"
(positions are the same as in Fig. 9)

S-E-C-R-E-T

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The trigger spring is released and moves the shaft, which turns the cocking lever. The cocking lever disengages from the small stop lever (8); simultaneously its long arm strikes boss "V" of stop lever (11).

The stop lever moves upward and becomes disengaged from rear carrying arm (15). [p 39]

Devoid of support, the carrying arms turn, and the load's lugs slide off the surfaces of the arms' catch. The lock levers assume the position "released" shown in fig. 10.

As the lock is opened, strikes by the arms are absorbed by vibration absorbers (9, 12, 26).

When current to the magnet winding is cut off, the armature is returned by spring (20) to its initial position.

Actuation of the lock under ground test conditions may be done mechanically, by pushing the end of the release lever where spring (20) is attached.

MBS (Mechanical Locking and Signalling) Mechanism

Signalling the presence of a load in the pylon lock, as well as release of load from the other pylon (under the other wing) when load drops spontaneously from one carrier, is accomplished by means of the locking and signalling mechanism (MBS).

The locking and signalling mechanism consists of housing (24), within which are placed three pairs of fixed contacts in the form of leaf springs and a shaft with end cap (22), pressed down by a cylindrical spring. The shaft's travel is 24±.5 mm.. Built into the upper part of the shaft are

two pairs of laminated contacts which slide over the fixed contacts. Next is fig. 9 "Lock DZ-57 and its electrical circuit. Position "Locked", page 39, and its description, page 40. Next is fig. 10 "Lock DZ-57.

Position "Closed" page 39-----

With load attached, the shaft and end cap are all the way up, [p 43] signalling contacts 1 and 2 and locking contacts 3 and 4 are closed, and locking contacts 5 and 6 are open, as shown in the circuit diagram in fig. 9.

When the load is released, the shaft with the end cap moves down pushed by the spring. Contacts 1-2; 3-4 open while contacts 5-6 close in order to feed voltage to the release mechanism electromagnet of the other lock (see fig. 10)

3. AVIATION LAUNCHING MECHANISM APU-13

Purpose

Aviation launching mechanism APU-13 is intended for attachment, conveyance, and launching of homing missile K-13 from launching aircraft.

Basic Technical Data

Missile separation force-----350 ± 35 kg.

Connector SR-20 separation force (the connector must separate only after locking latch is fully open) 300 ± 25 kg

APU-to-pylon holding force----- 900 ÷ 1200 kg.

Weight of APU-13 assembly----- 20 ± 1 kg.

Construction

APU-13 (fig. 11) is a box-type rectangular cross section beam (10) consisting of section, sheet strips, and plates of aluminum alloy riveted together. [p 44]

The launching mechanism is attached by lugs (23) of two yokes to two carrying arms of lock DZ-57 (41), mounted on wing pylon BDZ-60-21U (44). The yokes are located in the middle part of the beam of APU. Each yoke consists of a lug (23), connector, nut (45), lock nut (21), and casing (22). A pin is inserted through the casing and the slot in the lug, preventing rotation of the yoke's lug relative to the beam and the carrier lock.

When installing APU-13, its forward (25) and rear (20) braces are inserted into the matching braces (38, 42) of the pylon. They prevent shifting of APU-13 relative to the pylon and absorb loads acting on APU during flight.

The launching mechanism-to-ptylon tightening force equals 900-1200 kg and is ensured by using a torque wrench when tightening connectors nuts (45).

For installation of the missile and to provide direction in launching, the bottom of the APU beam has a special guide section (18) with longitudinal grooves into which the missile guides are fitted. In launching, missile guides slide along the grooves of the APU guide. Two apertures are made in guide section (18) to facilitate sliding of the missile guides into the grooves of the APU guide section when installing the missile on APU.

In front of the yokes, in the power part of the launching mechanism, is installed a retaining catch (32) in the form of a cast body with an oval slit for a rod, with two lugs on the bottom and two in its tail section (fig. 11, location B). The latch secures the forward guide of the missile, shifting on the APU [p 45] due to inertia.

A roller (33), ensuring a stable missile separation force of 350 ± 35 kg in launching, is installed in the forward lug of the latch. The degree of separation force is regulated by tightening springs (35, 36) located between flange (37) and base (34), the spherical part of which rests in the conical depression of the locking latch. Tightening or loosening of the springs is done by turning flange (37), the square end of which protrudes above the APU and is located under the guard plate.

The rear lower lug of the latch has the shape of a tooth and serves to restrict the position of the missile forward guide (48).

Inside the beam on lever axis (55) is installed lever (29), one arm of which is made in the shape of a curved fork, and the other -- as a foot with an adjustable screw support, which is pressed down by the tension of a spring attached to the neck of the fork-like arm. The fork-like lever arm rests against the bosses of antivibration plates while the arm with the screw support rests against the boss of the latch, made in the form of a ridge. In this position, the lever prevents opening of the latch and backward movement of the missile. The extent to which the fork-like arm overlaps the bosses of the

antivibration plates is controlled by means of graduation lines marked on the lever and the plates through inspection holes made in the APU beam's walls (the holes are covered with swivel cover plates). The lever graduation marks must not be moved beyond those of the antivibrator plates in the direction which decreases overlapping.

Opening of the latch is effected by means of a three-arm lever (27), the operation of which is described below:

The locking latch body has installed in it two insulating bushing with two sliding contacts (30, 31). One of these is connected in the firing cartridge circuit of the powder propellant igniter, and the other - in the firing cartridge circuit of the missile proximity fuse battery warning grain.

In order to eliminate play in the missile-to-APU attachment guides, four antivibrators are installed in the APU beam: two forward (one on each side of the latch), and two aft (in the area of the missile's rear guide). Each antivibrator represents a plate (15) (fig 11, area "B") placed between the beam's sidewall and plate (14) attached to the beam's sidewall. Each plate has two inclined grooves in which the plate lugs slide. The antivibrator plate is under pressure from spring (16) attached by one end to the beam and by the other to the plate. For this purpose, the rear antivibrator plates have shafts passing through a horizontal aperture in the plates, and the front plates have braces.

When a gap develops between APU and missile guides, springs (16) shift the plates in the inclined grooves, thus wedging the missile guides in the grooves of the APU guide.

The antivibrators are released (for example, when removing a missile from APU-13) by turning levers (46) and (27) in the direction of the arrow (marked on the outside of the body) with a socket wrench applied to the square end of the lever's shaft.

Lever (46), when turning, presses against the shafts of the rear antivibrator plates and displaces them. The plates come out of the guide's longitudinal groove and release the rear guide of the missile.

Lever (27), connected by the swivel joint of one of its three arms with the plate (26) resting on the guide (inside the beam), moves the latter when turning.

Plate (26) is shaped like a fork and has its ends resting against the butt end of the front antivibrator plates, moving them as the lever turns.

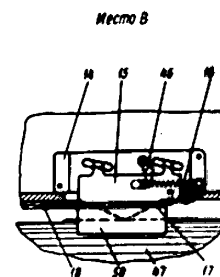
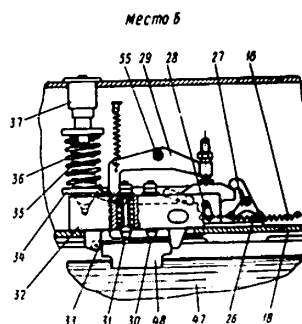
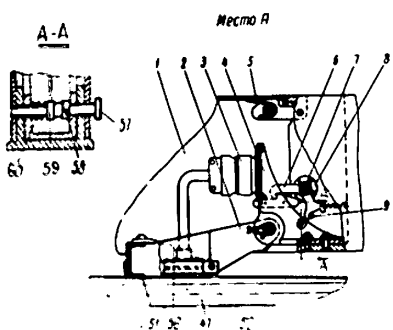
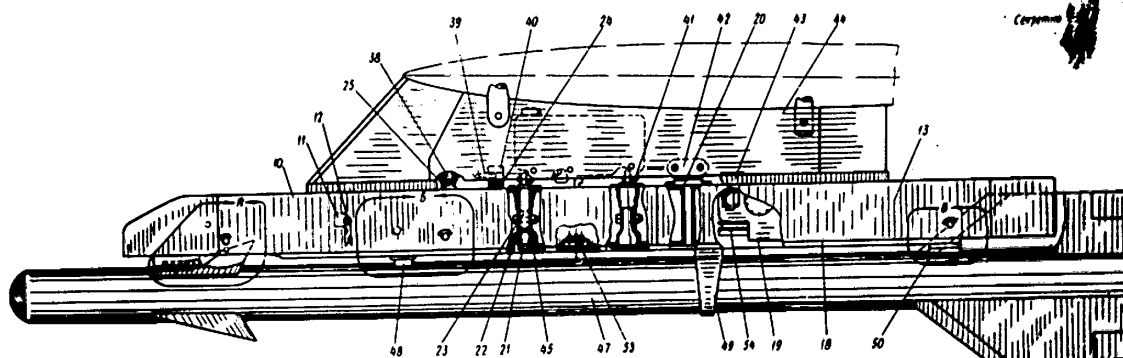
The antivibrator plates release the forward guide of the missile. At the same time, springs (16) stretch while the plate lugs are removed from under the fork-like lever arm (29), leaving it without support.

Further turning of lever (27) opens the locking latch, the arm resting on the ridge moves to the right; the other arm (free arm) acts against the end of the latch and lifts its rear end; at the same time the locking tooth of the latch sinks into the beam clearing the path for the missile guide.

Thus, in order to remove the missile and detach mechanism APU-13 from it, it is necessary to: unlock the antivibrators, open the retaining catch, slide the missile aft until its front guide rests against the fixed stop located on the bottom of the APU beam, and slide the missile's guides out of the APU guide grooves.

When the missile is removed from the launching mechanism, the retaining catch (32), movable plates, and levers (27), (29), and (46) are returned to their initial positions by spring action.

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Фиг. II. Авиационное цухоное устройство АТУ-13 и общая схема подвески ракеты К-13.

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50X1-HUM

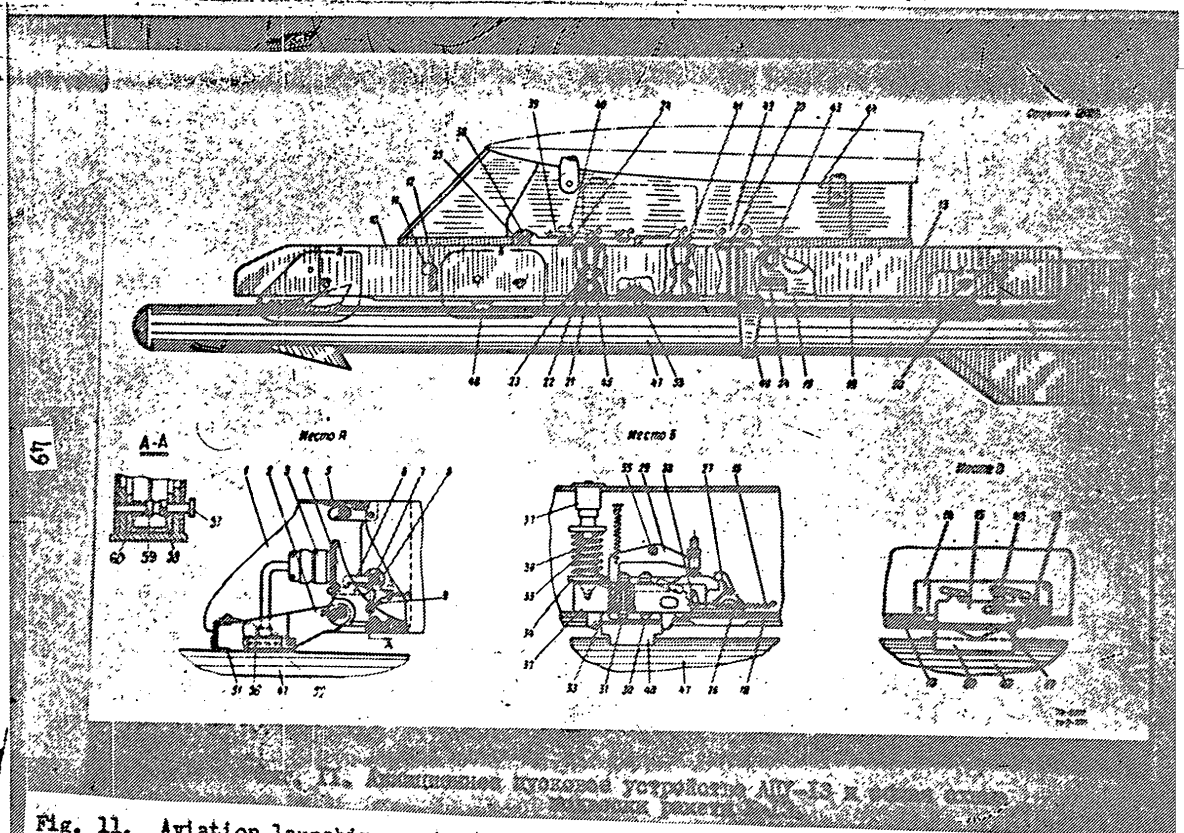


Fig. 11 Aviation launching mechanism APU-13 and
general diagram of missile K-13 attachment

1 - forward fairing; 2 - connector cut-off bracket; 3 - plug connector ShRM-20; 4 - bracket; 5 - spring on the forward fairing attachment shaft; 6 - hook; 7 - hook shaft; 8 - bushing; 9 - hook turning limiter; 10 - beam; 11 - switch KV-9-T; 12 - safety cotter pin with flag; 13 - housing; 14 - antivibrator plate; 15 - antivibrator plate; 16 - antivibrator spring; 17 - contact spring; 18 - guide; 19 - electric launching mechanism EPU-13; 20 - rear brace; 21 - lock nut; 22 - casing; 23 - lug; 24 - plug connector 2RM42B30Sh2V1; 25 - forward brace; 26 - plate; 27 - lever; 28 - latch shaft; 29 - stop lever; 30 - contact; 31 - contact; 32 - retaining latch; 33 - roller; 34 - base; 35 - spring; 36 - spring; 37 - flange; 38 - pylon forward brace; 39 - contact plug tightening lever; 40 - pylon contact plug; 41 - lock DZ-57; 42 - pylon rear brace; 43 - adapter beam; 44 - underwing pylon BDZ-60-21U; 45 - connector nut; 46 - lever; 47 - missile K-13; 48 - missile front guide; 49 - missile middle guide; 50 - missile rear guide; 51 - bracket blade-like plate; 52 - missile shear connector; 53 - negative bus; 54 - electric launching device plug connector N560-3; 55 - lever axis; 56 - spring; 57 - rod; 59 - bushing; 60 - spring.

In the aft part of the launching mechanism, under housing (13), is the electric launch mechanism EPU-13 (19), consisting of missile control, power supply, and starting units.

In order to connect APU-13 with the network of the launching aircraft, a miniature 30-pin plug connector (24) (plug) 2RM42BZOSHV1 is installed in its upper middle part, which plugs into female receptacle (socket 40) of wing pylon (44).

To connect the APU-13 circuit with the missile circuit, a 20-pin plug connector (3) type ShRM-20 is installed on bracket (4) in the forward part of the launching mechanism beam. Plugged into it is the cord of the missile shear-type plug connector SR-20. In the same area is a hinged spring bracket (2) with laminar snaps in each of its jaws. The bracket is fastened by means of these snaps to plug SR-20 as the missile is attached.

(page 49 contains a detailed drawing of the APU-13 launching mechanism with five different views "Fig. 11. Aviation launching mechanism APU-13 and general diagram of missile K-13 installation").

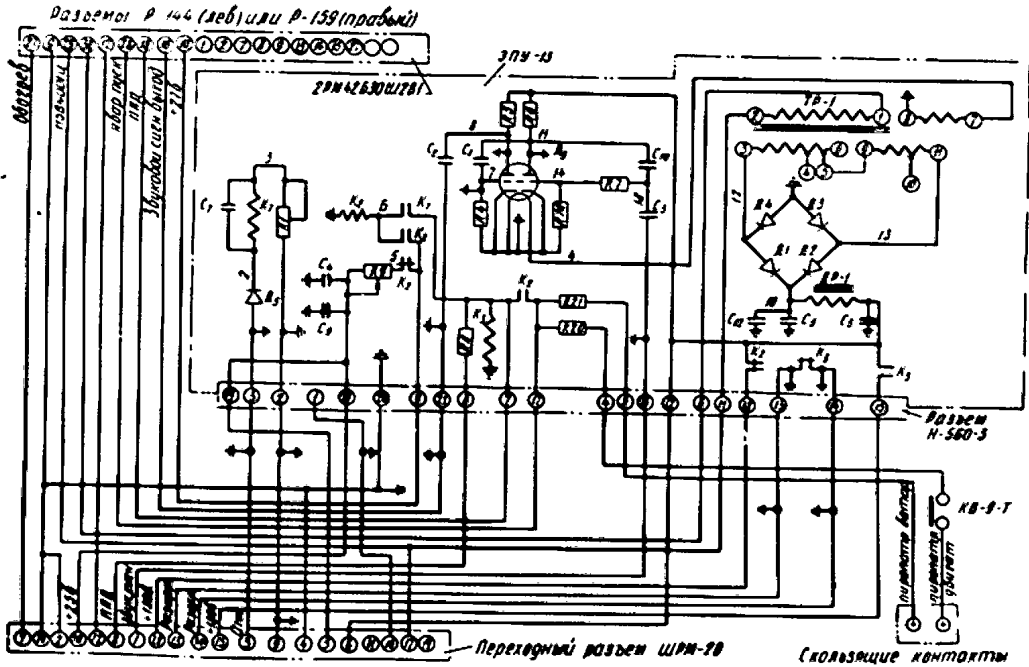
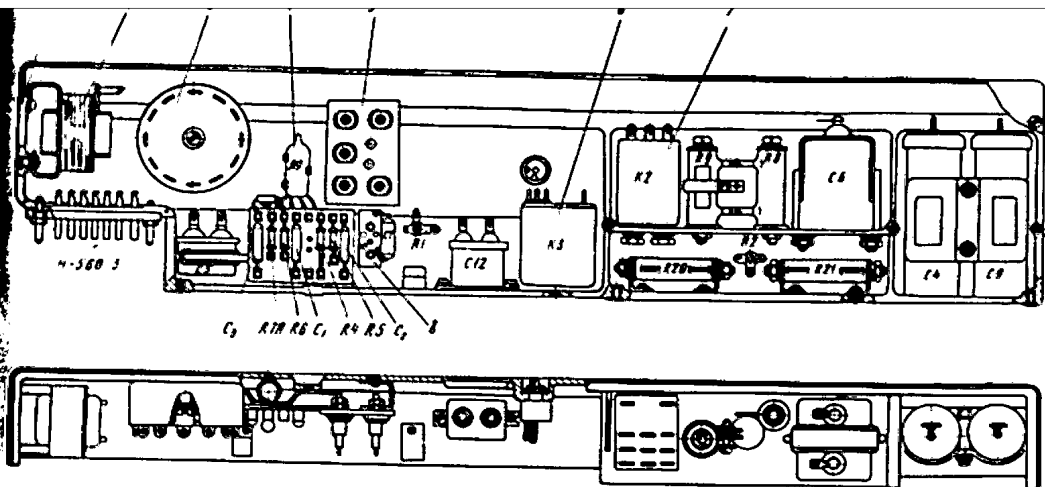
(page 50 contains detailed description of drawings on page 49).

When the missile slides off the guide, the protruding part of the terminal hits the blade-like stop plate (51) of the bracket, becomes disconnected, and is withdrawn into the launching mechanism together with the bracket. The plug is secured on the bracket by means of spring (56).

[p 51]

Access to ShRM-20 and the removable bracket is provided through hinged

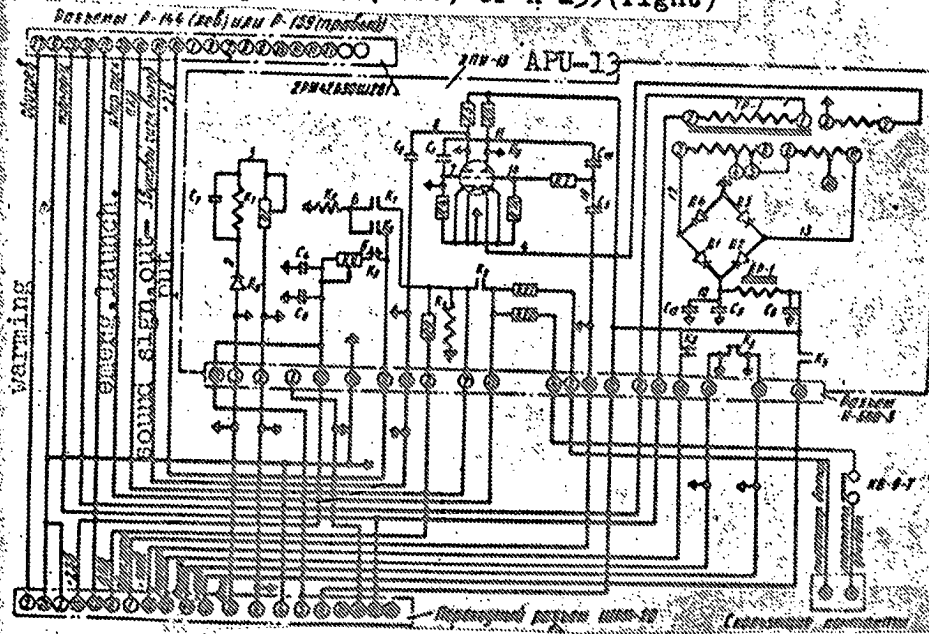
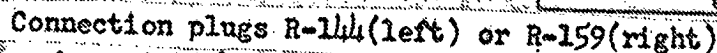
forward fairing (1) of the launching mechanism. The fairing, when closed, is secured by two hooks (6), which snap over lugs riveted to the fairing and are retained by a spring attached to the lower arm of the hooks.



Схем. 12. Принципиальная электроосхема АПУ-13. Электрическая и монтажная схемы электропускового устройства АПУ-13. (в скобках указаны позиции по электроосхеме).

- 1 - корпус АПУ-13, 2 - дроссель (ДР-1); 3 - трансформатор (ТР-1); 4 - радиолампа 6Н16Б (Л9); 5 - панель с диодами Д205 (Л1, Л2, Л3, Л4, Л5); 6 - реле ТКР-52ПД (К3); 7 - реле ТКР-53ПД (К2); 8 - реле РЭС-10 (К7); C1, C2, C3, C4, C5, C6, C7, C9, C10, C12 - конденсаторы; R1, R4, R5, R6, R7, R7A, R8, R9, R20, R21 - сопротивления.

50X1-HUM



Transient connection SHRM-20

Sliding contacts

[illegible]

Fig. 12. Schematic diagram of APU-13 electrical circuits.

Electric launching unit EFU-13 installation,

(shown in parentheses are positions in the
circuit diagram)

1. APU-13 housing
2. Choke
3. Transformer (TR-1)
4. Electron tube 6N16B (L9)
5. Panel with diodes D205 (D1, D2, D3, D4, D5).
6. Relay TKYE-52PD (K3)
7. Relay TKYE-53PD (K2)
8. Relay RZS-10 (K7), C1, C2, C3, C4, C5, C6, C7, C9, C10, C12 -----
capacitors; R₁, R₄, R₅, R₆, R₇, R_{7A}, R₈, R₉, R₂₀, R₂₁ - resistors.

Access to the hooks and lugs is provided by inspection holes in the sides of the fairing.

In order to ensure locking of the fairing, rod (57) is provided with bushing (59) whose shoulder, when the fairing is closed, is pressed by spring (60) against the lower arm of the hooks, preventing them from unlocking.

The hooks are unlocked from the outside by a socket wrench; at the same time spring (5) located at the fairing's attachment hinge pushes it upward.

Prior to releasing the hooks with a wrench, it is necessary to press the button of the rod in order to remove the bushing shoulder from under the lever.

A safety device consisting of end switch KV-9-T (11) and safety pin (12) with a flag is used to prevent accidental launching of missile on the ground. The pin, placed in a special aperture in the APU body, activates microswitch (11) which breaks the launching circuit.

Before flight, the safety pin is removed and the contacts of KV-9-T are switched on preparing the circuit for launching.

The launching mechanism electrical wiring is made of MGShV wire assembled in bunched conductor.

4. APPARATUS FOR DETERMINING MISSILE K-13 LAUNCHING RANGE

[p 53]

Missile K-13 operational range depends on the altitude of the launching aircraft: at higher altitudes, air density decreases, and missile range increases. In addition, missile range is influenced by the speed of the launching aircraft and closing speed of the target.

Calculation of these factors is performed by instruments which determine missile K-13 launching range, which include: range-only radar, permissible, range computer VRD-2A, air speed indicator DVS-5, and ambient air temperature adjuster P-5.

A. Range-Only Radar SRD-5MK

The range-only radar is intended for determining by radar means the target range, closing speed, and the exact time of effective launching of missile K-13.

The range-only radar, connected with the automatic gun sight ASP-5ND, provides the following when operating with the K-13 system:

- automatic and continuous determination of present (true) target range and presentation of this value to range indicator UD-1;
- automatic comparison of present range with permissible K-13 missile launching range and sending of launching permission signal to signal light "Permissible Range";
- signalling of necessity for withdrawal from attack by signal light "withdrawal from attack".

The following units and elements are included in the range-only radar complex: combined broad-and narrow-beam antenna (1), wave guide channel with ferrite switch (2), transmitter-receiver unit (54) radar receiver unit (6), power supply unit (7), control panel (5), speed unit (52), comparator unit (8), target clearing button (56), mode "B" range indicator UD-1 (58), mode "A" range indicator (on sighting head bracket), mode selector switch with sign "RS, GUN-SS" (Rocket, GUN-Missile) (39),

target lock-on signal light (on sight ASP-5ND head), signal light "Permissible Range" (59), and signal light "Withdrawal From Attack" (57).

The combined antenna of the range-only radar consists of broad- and narrow-beam antennas. The two antennas are installed in order to operate both the gun and unguided rocket system -- broad radiation pattern of 18° , as well as the K-13 missile system -- narrow radiation pattern of 5.5° (which ensures an operational range of the range-only radar that corresponds with missile operational range).

The position of switch "Rocket, Gun - Missile", denotes one or the other antenna being in operation.

The operating mode using range-only radar with gun and unguided rocket armament is called mode "A". The mode selector switch is placed in position "Rocket, Gun", in which case the radar sends present target range to sight ASP-5ND. Present range may be observed on the range indicator installed on the sight's head. Target lock-on is signalled by a green light with the sign "Lock-on" on the head of the sight (light is on).

[p 54]

The operating mode using K-13 missiles is called mode "B". The range only radar sends present target range to the comparator unit, compares it with the permissible launching range, and sends a signal to a green light with sign "Permissible Range".

In mode "B", target range data are sent to range indicator UD-1 installed above the range indicator of the sight.

Operational range of the range-only radar for fighter-type targets is:

in mode "A"-----not less than 1400 meters

in mode "B"-----not less than 4500 meters

With medium bomber type targets, operational range increases 1.3 times, and with heavy bomber type targets--1.5 times.

When range to target reaches 1000 meters, the range-only radar sends a signal which lights a red signal light with the sign "Withdraw From Attack".

The range-only radar units are located in the forward equipment hatch [p 55] in the nose section of the fuselage (see fig. 5).

Note: Arrangement of units of the range-only radar and its principles of operations are described in detail in book IV of the technical manual of the given aircraft.

B. Permissible Range Computer VRD-2A

VRD-2A is a potentiometer computing device. The device is fed static pressure from PVD (pitot-static head) of the aircraft, which activates the potentiometer's sliding contact through an aneroid, thereby determining the altitude of the launching aircraft.

Voltage proportional to true air speed of the launching aircraft is fed to the computer from airspeed indicator DVS-5, while voltage proportional to the target closing speed is supplied by the range-only radar. A special device consisting of a magnetic amplifier and electric motor DID-0.5 with reduction gear shifts the sliding contact's position in accordance with the indicated voltages.

As a result of this resistance, voltage proportional to the missile K-13 permissible launching range is obtained.

A scale graduated according to the ratio of speed (Km/hr) to altitude [p 56] (Km) of the launching aircraft is located on the front panel of the control instrument.

Computer VRD-2A is located in the forward equipment hatch between frames 4 and 5 under the hatch cover.

V. Airspeed Indicator DVS-5

DVS-5 is connected with the static and dynamic chambers of PVD (pitot-static head).

As a result of the effect of static and dynamic pressures upon the aneroid and the membrane, the position of the potentiometer sliding contacts changes, consequently altering the voltage obtained from them. This voltage is fed through the magnetic amplifier to electric motor DID-0.5 with reduction gear which turns the potentiometer sliding contact and changes the output voltage taken from the potentiometer proportionally to the true speed of the aircraft.

The instrument has a scale for control purposes which indicates the speed of the aircraft.

Air speed indicator DVS-5 is located in the forward equipment hatch between frames 4 and 5 under the radio communications transceiver.

G. Temperature Receiver P-5

Temperature receiver P-5 provides corrections for ambient air temperature.

The static and dynamic pressure, i.e. the accuracy of measuring the aircraft speed, depends on this temperature. [p 57]

Temperature receiver P-5 is located on the outside of the fuselage between frames 1 and 2 next to the DUAS mount on the right side.

Principle of Operation of Equipment

The equipment for determination of missile K-13 launching range operates as follows:

The range-only radar locks on the target and determines target range and closing speed, and provides a voltage proportional to the target range.

Airspeed indicator DVS-5 determines the launching aircraft's speed with corrections for ambient air temperature provided by temperature receiver P-5.

Computer VRD-2 determines the launching aircraft's altitude and produces a voltage proportional to the permissible missile launching range depending on the altitude and speed of flight and target closing speed. The output of the above mentioned voltage depends directly on the ratio between the launching aircraft speed and its flight altitude (the ratio is determined on the basis of ballistic characteristics of the missile).

A voltage proportional to the target range (provided by the ranging unit of the range-only radar) and the permissible launching range voltage (provided by computer VRD-2), are fed into a special electronic circuit [p 58] of the range-only radar comparator unit which compares them.

When these voltages become equal (i.e. when the permissible launching range is reached by the launching aircraft) the comparator circuit

functions and sends a signal voltage to a green signal light which reads "Permissible Range." Lighting of the light gives the pilot permission to launch the missiles.

In addition, the range voltage is fed into a special circuit of the comparator unit which, when the launching aircraft reaches a target range of one kilometer, turns on a red signal light which reads "Withdraw From Attack".

Range indicator UD-1, by which the true target range is observed is a voltmeter which measures range voltage but is graduated in kilometers from 0 to 8 km.

Equipment Power Supply

The range-only radar and computer VRD-2A power supply of +27 volts is provided by the aircraft's electrical network and is switched on by instrument AES (instrument electrical network) with the sign "SRD" (on the right hand electrical panel). The AES there upon switches on :

- converter PO-700A (through a high-current relay) from which an alternating current of 115 v, 400 cps is fed to the range-only radar;
- converter PT-500Ts (through high-current relay and PT-500Ts relay switch) from which an alternating current of 36 v, 400 cps is fed to computer VRD-2A.

Since the signal control circuits of the range-only radar are connected with the sight power supply circuits, it is first necessary to switch on AZS "Sight, Heater" and "Sight".

[p 59]

Converter PT-500Ts is installed in the forward equipment hatch between frames 4 and 5 on the lower right side under converter PO-500A of the sight power supply.

The high voltage of the range-only radar is turned on by a switch with the sign "Radio-Optics" (on the right side of the sight bracket), which is turned to position "Radio." This also turns on a neon signal light with the sign "RD. High Voltage." This makes it possible to turn on the range-only radar only when necessary, thus minimizing the possibility of the launching aircraft being discovered. No time is required to switch the range-only radar to radiation.

5. APPLICATION OF SIGHT ASP-5ND IN THE K-13 SYSTEM

Sight ASP-5ND is used on the aircraft for aimed launching of unguided rockets and gun firing.

The sight is used in system K-13 as an ordinary collimator viewer; therefore, the handle of arrester "Gyro-Stationary" of the sight head must be turned to position "Stat." The position of the sight grid, in this case is in line with the armament axis direction, i.e. $1^{\circ}30'$ down. In this way, when aiming by means of the stationary grid of the collimator sight, the aircraft is oriented in the direction necessary for target lock-on by the missile homing heads.

Arrangement of the sight units and brief information concerning the sight may be found in chapter VI. [p 60]

6. INFRARED SIGHT SIV-52

Infrared viewfinder SIV-52, optically linked with sight, is installed on the aircraft for night flying.

SIV-52 is intended for tracking of target aircraft by infrared irradiation of the target and for sighting.

The SIV-52 assembly is installed next to the sight head in place of gun camera SSh-45-1-100-OS, which in this case is removed from the aircraft.

The SIV-52 viewfinder assembly includes the following units: tracking unit, power supply unit, high voltage cable, optical element OES-2 which links SIV-52 and ASP-5ND.

The arrangement of the units of SIV-52 and a brief description of it are given in chapter VI.

7. MISSILE K-13 LAUNCHING CONTROL SYSTEM

The missile launching control system is fed by +27 v d-c from the aircraft network, and an alternating current of 115 v, 400 cps from converter PO-500A, installed in the forward equipment hatch between frames 4 and 5.

The electrical circuit provides for missile warning, switching on the filament and launching circuits, interlocking launch with the landing gear, possibility of launching a two-missile salvo or each missile separately, and signalling presence of missiles on the aircraft. [p 61]

The K-13 missile electrical launching control system (see fig. 14) includes the following elements and devices:

- two electrical launching mechanisms EPU-13, installed inside the corresponding launching mechanisms APU-13:
- overload indicator MP-28A, installed behind the cockpit canopy near frame 12 on the left;
- altitude signalling device VS-14500, installed in the forward equipment hatch on the upper left side between frames 2 and 2A;
- control equipment:
 - a) manual, installed in the cockpit: AES, switches, buttons (see fig. 13);
 - b) automatic, installed in relay boxes: switching relay for rocket and missile launching control circuits (pos. 26P), relay for blocking missile and rocket according to nose gear position (pos. 20B), missile launching circuit, actuation relay (pos. 37B), overload signal circuit switching relay (pos 34B) and others (see arrangement in book IV of technical description of this aircraft);
- light signalling (information and warning) in the nature of signal lights of the SMTs-51 type with colored light filters installed in the cockpit (see fig. 13).

The mechanisms of each missile are connected with the airborne missile [p 62] control electrical circuits by means of the following plug-type connectors (see fig. 14):

- ShR-55 connecting the wing pylon with electric wiring inside the aircraft wing;
- 2 RM connecting launching mechanism APU-13 with the pylon;

- ShRM-20, 20-contact plug in the launching mechanism;
- N560 plug connecting the EPU-13 electric launching device in the APU-13 launching mechanism;
- SR-20, 20-contact shear type plug connecting the missile with launching mechanism APU-13;

Transmission of pulses to the firing cartridge of the motor and the proximity fuse-battery warning grain of each missile is accomplished through special sliding contacts installed in the APU-13 locking latch and in the forward guide of the missile.

A. Electrical Launching Mechanism EPU-13

EPU-13 (fig. 12) is intended for feeding a stabilized voltage of 180 v and 25 v to the missile anode and filament circuits, ensuring the necessary switching of mechanisms at the moment of launching, and amplifying the audio signal of target lock-on by the missile homing heads.

EPU-13 consists of a cast housing - 1, with a cover jacket. EPU-13 is fastened inside the APU-13 beam and is connected with the beam's circuit by socket N560-3.

Inside the EPU-13 housing are installed parts and units of its electrical circuit.

[p 64]

B. Overload Indicator MP-28A

Overload indicator MP-28A represents a two-stage signalling device intended for turning on the overload signal light ("Overload Signal") warning the pilot that launching of missiles under the given flight conditions

is not to be carried out and that reduction of overload is necessary. At altitudes up to 14500 m, missile launching is permitted with overloads not exceeding 2, and at altitudes above 14500 m -- with overloads not over 1.6.

Switching of overload indicator stages is done automatically by means of the altitude signalling device and overload signal circuit switching relay.

V. Altitude Signalling Device VS-14500

The altitude signalling device VS-14500 is a sensitive barometric pressure element used for switching the circuits of the overload signal light from one stage of the overload indicator to another depending on the flight altitude. Upon reaching an altitude of 14500 m, the altitude signalling device cuts in the switching relay of the overload signalling light and switches these circuits.

G. K-13 Missile Launching Control Instruments and Control System Signal Lights - Their Purpose and Arrangement in the Aircraft Cockpit. [p 65]

Shown in figure 13 is the arrangement of armament installation control instruments and signal lights in the aircraft cockpit. Following is a list of those which pertain to the K-13 missile launching system. All signs are in quotation marks. In addition, instruments directly connected with the preparation and launching of missiles as such are underlined; instruments involved in the control of related units of the homing system are not underlined. A list of control instruments of other armament installations is given in the appropriate chapters.

On the front right hand electrical instrument panel are installed:

- AZS-20 (circuit breaker) "Sight, sight Warning" (pos. 1P);
- AZS-10 "Sight" (pos. 2P).

The range-only radar signal circuits are connected through these circuit breakers.

- AZS-5 "SIV-52" (pos. 46p). The aircraft network voltage is fed through this to the infrared sight power supply unit.

- AZS-5 "SRD" (range-only radar) (pos. 6P). The aircraft network voltage is fed through this, ^{for} actuation of converter PO-750A, to the range-only radar control panel, and for actuation of converter PT-500Ts to supply power to computer VRD-2A. To turn on the range-only radar, sight switch "Radio-Optics" must be placed in the position "Radio".

- AZS-20 "SS Warming" (pos. 28B) Through it the aircraft network voltage is fed to thermoregulator and solid propellant hot gas generator warming elements (PAD). Upon reaching the prescribed upper limit of warming temperature the thermoregulator contacts break and warming of PAD ceases.

[p 66]

- AZS-10 "SS Filament" (pos. 29B) Through it the aircraft network voltage is fed to the overload signal light, missile presence (separation) signal lights, and the altitude signalling device; to the electrical launching devices EPU-13 and through them to the missile homing head filament circuits, and also (through relay pos. 3P) for actuation of converter PO-500A for supplying 115 v, 400 cps. to the K-13 system. Feeding of power to EPU-13 (+27 v and 115 v, 400 cps) is blocked by the high-current cut-off relay (pos. 17E).

- AZS-10 "SS Launching" (pos. 30B). Power is fed through this to the missile launching circuits. The launching circuits are blocked by a relay when the nose L. G. strut is in a retracted position.

On the rear right hand electrical instrument panel are installed:

- AZS-5 "NR, SS, RS, FKP" (pos. 17P). Through it 27 volts is fed to the mode operation switch of the range-only radar and to the windings of the switching relay and firing circuit $\wedge$ to the cut-in relay of the launching and firing circuits (by pressing the firing button installed on the aircraft control stick handle);

RS, APU, Emerg. Missile Launching"
- AZS-20 "Fuel Tank Emergency Prop $\wedge$ " (pos. 9B). Through this are supplied the emergency missile launching and missile carrier emergency drop circuits (by pressing the appropriate emergency buttons)

[p 67]

- AZS-5 "Tank Attachment Signal, RS, APU" (pos. 1B). Through it is applied a voltage to the signal light indicating attachment of launching mechanisms APU-13 to pylons BDZ-60-21U.

On the left hand panel are installed:

- Switch VT3602006SP "RS, Pushka - SS" ["Rocket, Gun - Homing Missile"] (pos. 24P) for operating modes of range-only radar and firing circuits.

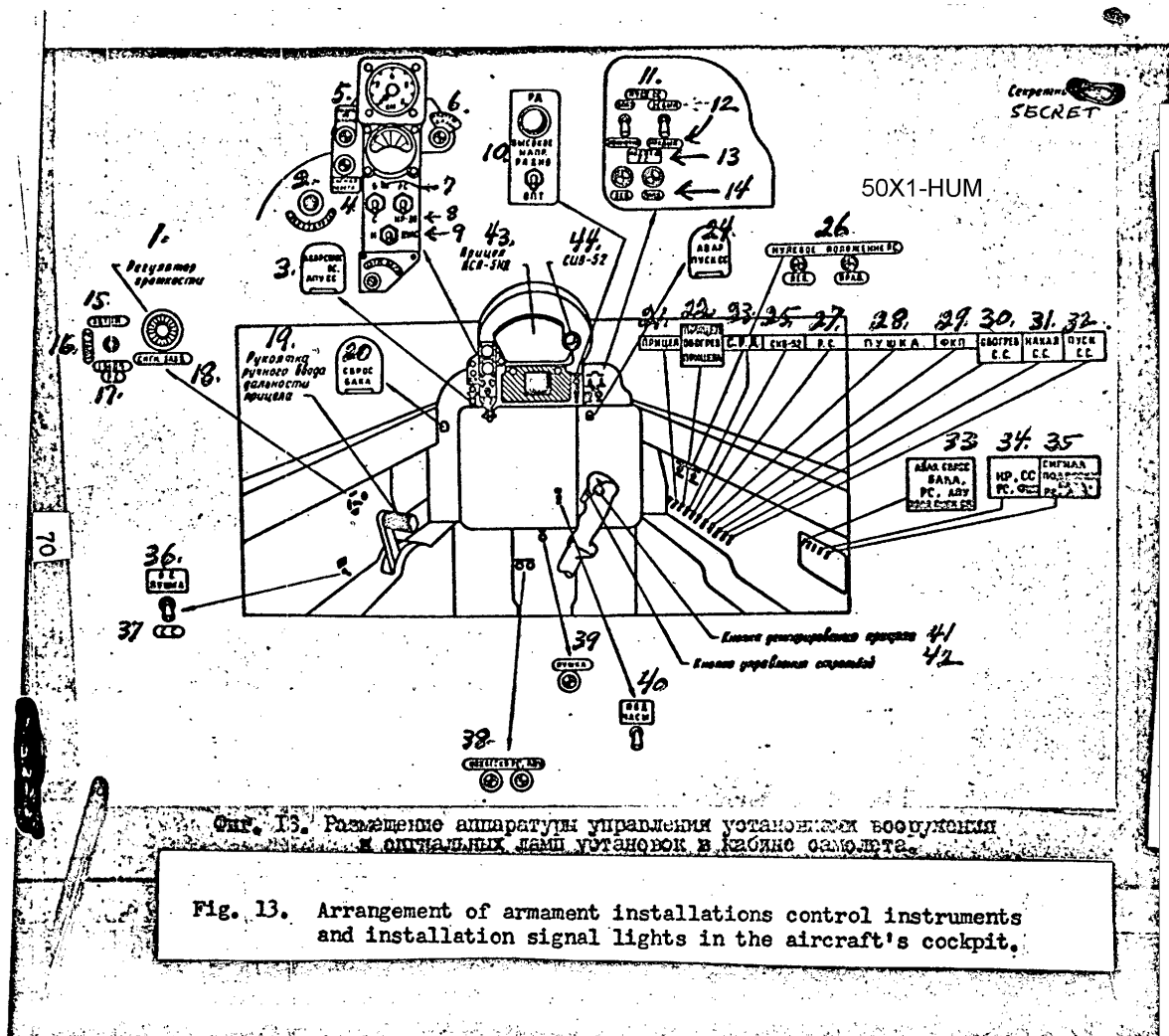
- Rheostat "Lock-on Signal" (pos. 19B), serving to control the loudness of the audio signal fed to the pilot's helmet set from the missile homing heads.

Installed on the instrument board are:

a) On the upper right hand panel:

- Individual missile launching selector switch 2NP-45 "Puskss, lev-prav."

["Homing Missile Launching, Left-Right".] It provides for separate launching of each missile and separate reception of their audio signal.



Key to Figure 13

- | | |
|--|---|
| 1. loudness control | 23. S.R.D. |
| 2. re-load | 24. Emergency launch SS |
| 3. emerg. jettison RS. APU SS | 25. SIV-52 |
| 4. Overload signal | 26. Zero position R.S. -- left/right |
| 5. withdraw from attack | 27. R.S. |
| 6. permissable range | 28. gun |
| 7. B/S | 29. FKP |
| 8. RS/NR-30 | 30. warming S.S. |
| 9. N/DUAS | 31. filament S.S. |
| 10. High-voltage radio.
Radio (RA) Optics (Opt) | 32. launch S. S. |
| 11. launch SS - salvo - left | 33. emerg. jettison of drop
tank, RS, APU Emerg.
launch S. S. |
| 12. single - right | 34. NR, SS, RS, FKP |
| 13. attachment SS | 35. signal for attachment of drop
tank, RS, APU |
| 14. left - right | 36. RS, gun |
| 15. automatic | 37. SS |
| 16. 2 salvos | 38. attachment RS, APU |
| 17. 1 salvo/R.S. | 39. gun |
| 18. lock-on signal | 40. PVD/clock |
| 19. handle for manual
introduction of range | 41. sight damping button |
| 20. tank jettison | 42. firing control button |
| 21. sight | 43. sight ASP-5ND |
| 22. sight warming - sight | 44. SIV-52 |

- Missile salvo launching switch 87K "PuskSS, zalp-ordinochno"
["Homing Missile Launching, Salvo - Single"] (pos. 33B). When the switch is turned to position "Salvo", both missiles are launched simultaneously. (In this case the position of switch "Homing Missile Launching, Left-Right" is immaterial; it is used only for separate reception of missile launching signal). When the switch is turned to position "Single" each missile is launched separately. [p69]

- Two signal lights (green) "Podvesheny SS, lev-prav." ["Homing Missiles Attached, Left-Right"] (pos. 31B, 32B) - They indicate the presence of K-13 missiles on launching mechanisms APU-13 and go out when missiles separate from the launching mechanisms.

b) On the mount attached to the switch panel of the sight, on the left side:

- Range indicator "UD-1" with a scale of 0 to 8 km indicating present target range determined by range-only radar.

- Signal light (red) "Signal peregr." ["Overload Signal"] (pos. 27B) indicates that the overload value exceeds that permissible for missile launching.

- Signal light (green) "Razreshennaya dal'nost" ["Permissible Range"] (pos. 26R) indicates that the distance of the launching aircraft from the target equals the permissible missile launching range.

- Signal light (red) "Vykhod iz ataki" ["Withdraw from Attack"] (pos. 25R) warns the pilot that launching of missiles at the given target range is forbidden in order to prevent the aircraft from being struck by its own missile.

v) On the instrument board panel:

- Button 204 KS "Avar. Pusk SS" ["Homing Missile Emergency Launching"] (pos. 22B). It serves to feed +27 volts to the powder firing cartridges of both missiles in emergency launching. When the button is pressed, the missiles separate from the launching mechanisms. [p 70]

g) On the left hand panel of the instrument board are installed:

- Button 205K "Avar. sbros RS, APU-SS" ["Emergency Drop RS, APU-SS"] (Rocket, Missile Launching Mechanism-Homing Missile Emergency Drop) (pos. 23B). It serves to supply 27 volts to the electromagnetic release mechanisms of the DZ-57 locks of the pylon. When the button is pressed, launching mechanisms APU-13 together with missiles are dropped from the aircraft.

Installed on the center panel under the instrument board are:

- Two signal lights (green) "Podveska RS, APU" ["Rockets, APU Attached"] (pos. 24B, 25B). These indicate the presence of launchers APU-13 on the pylons. If the APU-13 are attached to missiles, the lights go out upon an emergency drop of launchers APU-13 and the missiles.

On the handle of the aircraft control stick are installed:

- Boevaya Knopka [firing button] (pos. 18P). Pressing this button causes closing of the relay coils which switch on the prepared SS (or RS) release circuits and launch the missile.

8. K-13 MISSILE LAUNCHING

a) Preparation for missile launching

Launching of K-13 missiles is carried out after guiding the aircraft -- "locking on" the target and receiving signals permitting launching.

When operating the sight and range-only radar, the following circuit breakers must be turned on:

[p 71]

- "Sight, sight warming";
- "Sight";
- "SRD" (range-only radar)

Sight selector switch "Radio-optics" must be turned to position "Radio"; the arrester handle on the sight head--to position "Stationary."

At night, when using viewer SIV-52, AZS "SIV" must be turned on.

The following circuit breakers must be turned on for missile launching:

- "NR, SS, RS, FKP (Gun, Homing Missiles, Unguided Rockets, Gun Camera)

- "Missile Warming";
- "Missile Filament";
- "Missile Launching";
- "Tank, Rocket, APU Emergency Drop, Emergency missile launching,"

These circuit breakers (AZS) except AZS "Missile Launching" are turned on the ground. AZS "Missile Launching" is turned on after the aircraft takes off but not more than 5 minutes prior to missile launching.

During this time, with missiles attached, the following signal lights are on:

- two signal lights "Missiles Attached, left right."
- two signal lights "Rocket, APU Attachment" (the latter are on if the AZS "Tank, Rocket, APU Attachment" is turned on).

Prior to missile launching, the following operating and launch mode selector switches must be placed in operating position:

- selector switch "S-B" on the sight operating mode switch panel [p 72] must be turned to position "S", and switch "NR-30-RS" to position "NR-30";
- range only radar mode and firing circuit selector switch "Rocket, Gun-Missile" - to position "Missile";
- missile launching selector switch "Missile Launching, Salvo, Single" is placed in position "Single" for launching single missiles, and the separate missile launching selector switch "Left - Right" -- in position "Left" for launching the left missile, or in position "Right" for launching the right missile. When launching a missile salvo, selector switch "Salvo, Single" must be turned to "Salvo" (in flight the order of missile launching is determined by the pilot who operates the switches accordingly).

b) Missile launching

The launching aircraft armed with missiles is led by the pilot along the pursuit curve which he achieves by constantly keeping the fixed sight grid in line with the target. At the same time, the aircraft is provided the necessary orientation for target lock-on by

the missile homing heads. The range-only radar determines the present range to target. The electrical arrester holds the homing head axis of each missile in line with the missile axis, while the latter's direction is coordinated with the line of sighting. The homing heads send an audio signal to the pilot's helmet set. The volume of the signal is regulated by the loudness control.

At the moment the target range corresponds to the sensitivity threshold of the homing heads, target lock-on takes place and the pilot is informed of this by a change in the tone and level of the audio signal. Present target range is controlled by the pilot by means of range indicator UD-1. [p 73]

The range voltage provided by the range-only radar range unit, and the permissible range voltage provided by computer VRD-2A on the basis of flight altitude and speed are fed to the comparator unit.

As the launching aircraft reaches the maximum permissible launching range, the range voltage becomes equal to and then greater than the voltage fed from VRD-2A. The comparator circuit is actuated and turns on the signal light "Permissible Range"; the light goes on, informing the pilot that missiles may be launched.

Overload indicator MP-28A and altitude signalling device VS-14500 ensure turning-on of the signal light "Overload Signal" under conditions when the acceleration exceeds the value 2 at altitudes up to 14500 meters, and 1.6 at altitudes over 14500 meters; the light goes on warning the pilot that missile launching is forbidden because of overload.

Thus, the conditions necessary for missile launching are:

- 1) Audio signal of a definite tone received by the pilot's helmet set indicating target lock-on by the missile homing heads (or head);
- 2) Burning of signal light "Permissible Range." (burning of the light at the time of launching guarantees that the missile will reach its target);
- 3) Signal light "Overload Signal" is off. (otherwise, the missile will not be able to strike the target due to overload).

[p 74]

Upon fulfilling all the necessary launching conditions, the pilot launches the missiles by pressing the firing button on the handle of the control stick.

Pressing the button sends a voltage to the firing cartridge of the missile solid-propellant hot-gas generator (PAD).

Simultaneously with the actuation of PAD, the missile homing head coordinator unlocks and assumes the nature of a tracking gyroscope, and ignition of the motor and the missile warming proximity fuse grain takes place.

The missiles slide off the APU-13 guides, shearing the contact plug, and proceed toward the target as homing missiles. Signal lights "Missiles Attached, left right" go off.

When present range coincides with minimum permissible range (1 km) the comparator circuit turns on signal light "withdraw from Attack" which warns the pilot of the necessity to veer off the target course immediately in order not to be hit by fragments of his own launched missile.

v) Emergency missile launching

Emergency missile launching is accomplished by pressing the button "Emergency Missile Launching" (on the instrument panel). This sends a voltage to the firing cartridges of the powder igniter of both missiles (by way of the sliding contacts of APU-13 and the missiles). The missiles separate from the launching mechanisms unguided. Signal lights "Missiles Attached, left right" go off.

[p 75]

g) Emergency jettison of launching mechanisms APU-13 With missiles

Emergency jettison of the launching mechanisms with missiles is accomplished by pressing the button "Emergency Drop, Rockets, APU-Missiles" (on the instrument panel). This actuates the wing pylon locks DZ-57 and releases launching mechanisms APU-13 with missiles from the aircraft. Signal lights "Rockets, APU Attached" and "Missiles Attached, left right" go off.

Operation of emergency jettison electrical circuits of the launching mechanisms is described in chapter III, paragraph "Operation of rocket emergency jettison electrical circuit."

9. OPERATION OF ELECTRICAL LAUNCH CONTROL SYSTEM OF K-13 MISSILES

Figure 14 shows the schematic electrical diagram of the K-13 missile electrical launch control system. For simplification, locks DZ-57 in the wing pylons, APU and rocket emergency jettison circuits, and signal lights "Rocket, APU Attachment" are not shown (however, they are shown in the diagram of unguided rocket launch control,

chapter III, fig. 20). Also not shown is the missiles' electrical circuit, but a schematic diagram of electrical launching mechanism APU-13 is given (separately, on the right).

[p 76]

All elements in the diagram are numbered; given in parentheses are identification markings in accordance with electrical equipment specifications.

When missiles are attached, safety keys with flags are removed from each launching mechanism and the circuit breakers and selector switches are turned to operating positions as described in paragraph 8; control instruments are placed in positions shown in figure 14.

Operation of missile attachment signalling circuit (prior to and during flight)

When both the left and the right missile are attached to APU-13 launching mechanisms the minus circuits of signal lights 15 (31B) and 16 (32B) "Missiles Attached, left-right" are closed through terminals "12" of plug connectors SR-20, 2RM, and SShR-55 and the normally closed contacts of the malfunction monitoring relay of lights 23 (24S). When turning on circuit breaker "Missile Filament" (5, pos. 29B), the aircraft line voltage is fed to the lights and they are turned on.

When launched in flight, the missiles separate from APU-13, the minus circuits of the lights break, and the lights go out.

In order to monitor the condition of these lights, as well as signal lights "Permissible Range" 14 (26R), "Withdraw From Attack" 13 (25 R), and "Overload Signal" 12 (27B), it is necessary to press the button on light register T-6. This sends the aircraft line

voltage to the coil of relay 23 through circuit breaker "Light Register. [p 77]
Monitor, Fuel Reserve, Trimmer Effect Signal" (pos. 31E) and the button
contacts of the T-6 light register. Relay 23 is actuated and closes
the negative circuits of all lights; in this case, the lights in good
repair must be lit.

Operation of missile power supply electrical circuit (in flight)

The warming circuits as well as the filament and anode circuits
of the missiles are blocked against high current by means of a high-
current disconnecting relay 21 (17E). The relay turns on the missile
warming and filament circuits only in case a starter-generator or a
ground source of power is attached to the aircraft line network.

When circuit breaker "Missile Warming" (4, pos. 28B) is turned
on, 27 volts is fed to the warming elements of the missile solid-
propellant hot-gas generator (PAD) through the contacts of high-
current relay 21 (17E), terminals "27" of connector plugs ShR-55 and
2RM (of the pylon and APU-13), terminals "7" of shear-type plugs SR-20
(of the missiles), and the thermo-regulator. The latter maintains the
warming temperature of the PAD grain within the limits of $+10^{\circ}$ to $+30^{\circ}\text{C}$.

A direct current of $+25\text{ v}$ and $+18\text{ v}$ is fed to the missile homing
head anode and filament circuits from electrical launching mechanism
APU-13, which, for this purpose, utilizes and converts the aircraft
line voltage of $+27\text{ v}$ and 115 v , 400 cps from converter PO-500A
(pos. 15R).

When the circuit breaker "Missile Filament" (5, pos. 29B) is turned on, the aircraft line voltage (+27 v) is fed through the contacts of high-current relay 21 (17E) and terminals "10" of the pylon and APU connector plugs to terminal "9" of EPU-13 to feed the EPU-13 commutating equipment. From here the voltage is fed through normally closed contacts K_2 to resistor R_9 , where it is stepped down to +25 v, and further, through terminals "10" of EPU and plug SR-20 to the filament circuits of the missile homing head. [p 78]

From the other side, +27 volts is fed from the circuit breaker "Missile Filament" through high-current relay 21 (17E) to the converter 25(3P) actuating relay coil; the relay triggers converter PO-500A and from it feeds on alternate current of 115 v 400 cps through terminals "29" of plugs ShR-55 and 2 RM and through terminal "11" of EPU-13 to the primary winding of transformer TR-1. The transformer feeds the rectifier and filament L9 of EPU-13. The rectifier converts the 115 v alternating current to a direct current of 180 v $\pm 10\%$.

A voltage of +180 v is fed through normally closed contacts of relay K_2 and terminals "18" of EPU-13 and shear plug SR-20 to the anode circuits of the missile homing heads. (This voltage is also used to feed the anode circuit of the audio signal amplifier installed in EPU-13, as well as the rudder trim neutralization circuit).

Operation of Overload signal circuit (in flight)

[p 79]

When the "Missile Filament" circuit breaker is turned on, + 27 volts is fed through the contacts of high-current relay 21 (17E) to terminal "1" of altitude signalling device VS-14500-32 (26B), whose contacts remain open at altitudes up to 14500 m. Consequently, the positive circuit of the altitude signalling device, connected to the switching relay of the overload signal circuits 22 (34B), is open and the relay winding is de-energized, while its contacts close the minus circuit of the overload signal switching relay 26 (21B) through the first stage sliding contact of overload indicator MP-28A 31 (35B).

From the other side of the same "Missile Filament" circuit breaker, + 27 volts is fed to the winding of the overload signal switching relay 26 (21B), actuating it through relay contacts 22, terminal "3" of overload indicator 31, the first stage sliding contact, and terminal "1"-minus. Relay 26 opens and keeps the circuit of the signal light "overload Signal" 12 (27B) open.

In case of overloads of 2 or more, the first stage sliding contact of the overload indicator 31 (35B) slides over the insulator and breaks the minus circuit of overload signal switching relay 26 (21B). The relay releases, closing the contacts of the signal light circuit. The aircraft line voltage is fed to the signal light "Overload Signal" through circuit breaker "Missile Filament", contacts of relay 26, and the normally closed contacts of signal light malfunction monitoring relay 23 (24S). The light goes on. When overload is removed, relay 26 is actuated and turns the light off.

Upon reaching an altitude of 14500 m or more, the contacts of altitude signalling device 32 (26B) close and remain closed, cutting in the winding of the overload signal switching relay 26 (21B). The relay is actuated and closes the minus circuit of overload signal actuating relay 26 (21B) by way of the second stage sliding contact of overload indicator 31 (35B). In case of overloads of 1.6 or more, the second stage sliding contact moves over the insulator and breaks the minus circuit of the overload signal relay 26 (21B), which turns on the signal light "Overload Signal", as was described previously.

[p 80]

Operation of Lock-on audio signal circuit

From the moment the missile homing head locks on the target, a sound signal in the form of amplitude-modulated oscillations with a carrier frequency of 800 cps and a modulation frequency of 66 cps is formed in an electronic unit of the homing head.

This signal is sent through terminals "1" of shear plugs SR-20 and terminals "16" of EPU-13 to the audio signal amplifier (tube 6N16B-L9) of the electric launching mechanisms. The amplified signal is sent from the amplifier through terminal "21" of EPU-13, terminals "16" of plugs 2RM and ShR-55, and the contacts of separate missile launching switch 10 (36B) to sound volume regulator 11 (19B); from there it goes to radio communications equipment, and from there to the pilot's helmet set.

Operation of signal circuit for missile launching permission
and withdrawal from attack

[p 81]

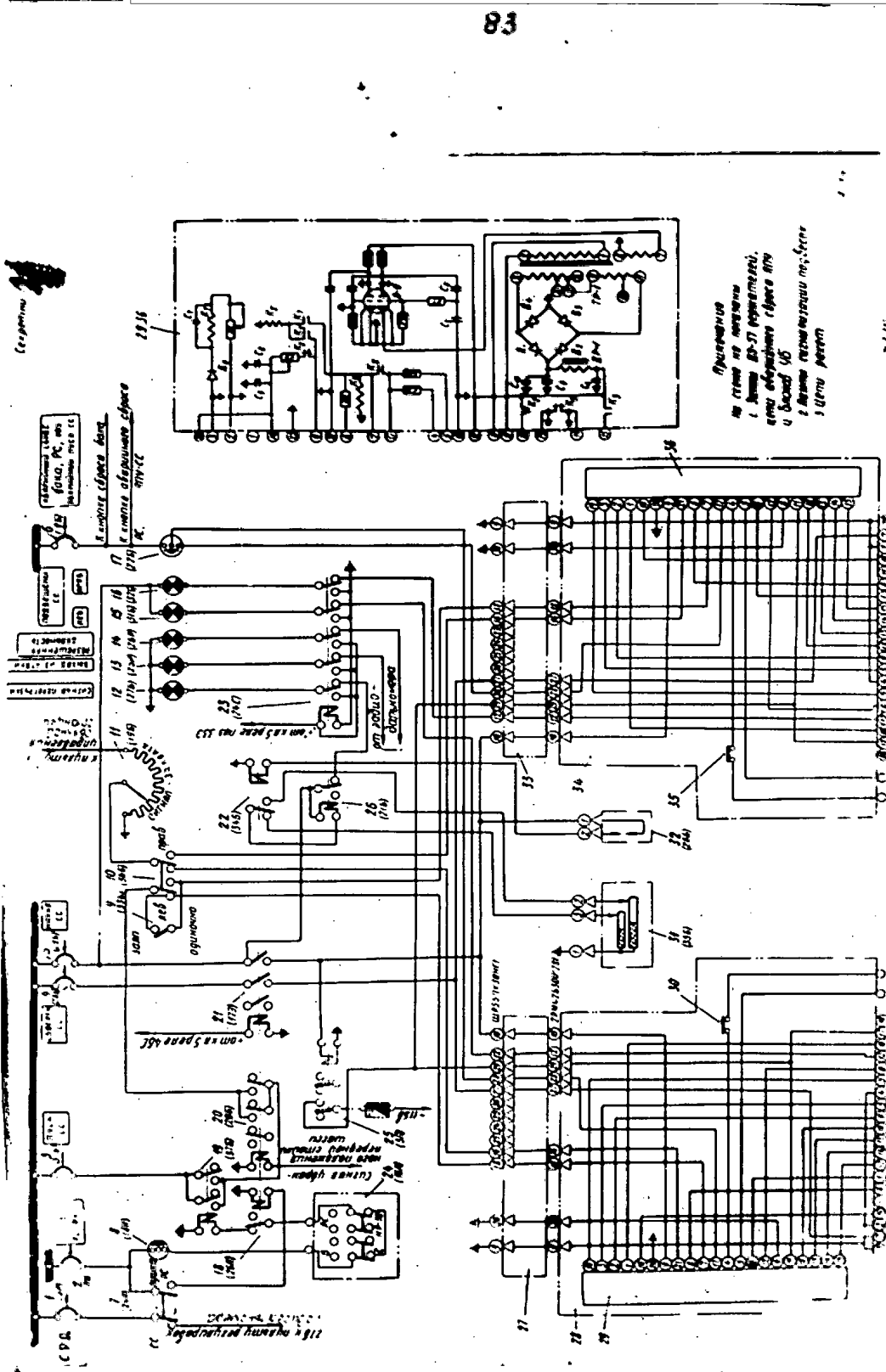
Signal lights "Permissible Range" 14 (26R) and "withdraw From Attack" 13 (25R) are connected to the output of the range-only radar comparator unit. In the comparator unit, the permissible range voltage received from VRD-2A is compared with a voltage proportional to the true target-aircraft range. When these two voltages are equal, voltage is sent from terminal "25" of plug Sh-12 on the range-only radar through the normally closed contacts of the light malfunction monitoring relay 23 (24S) to light "Permissible Range." The light goes on.

Operation of missile launching electrical circuit

The missile launching circuits are interlocked with the position of nose L.G. strut by means of relay 20 (20B). The relay turns on the launching circuits and renders them operational only after aircraft take-off and retraction of L.G. has been accomplished. (when the nose L. G. strut is retracted, the end switch is actuated, cutting in the coil of relay 20).

Upon receiving through his helmet set the audio signal of target lock-on by the missile homing heads, and after lighting of the "Permissible Range" signal light, the pilot may carry out missile launching. When the missiles are launched, the "Overload Signal" light must not be burning.

[p 82]



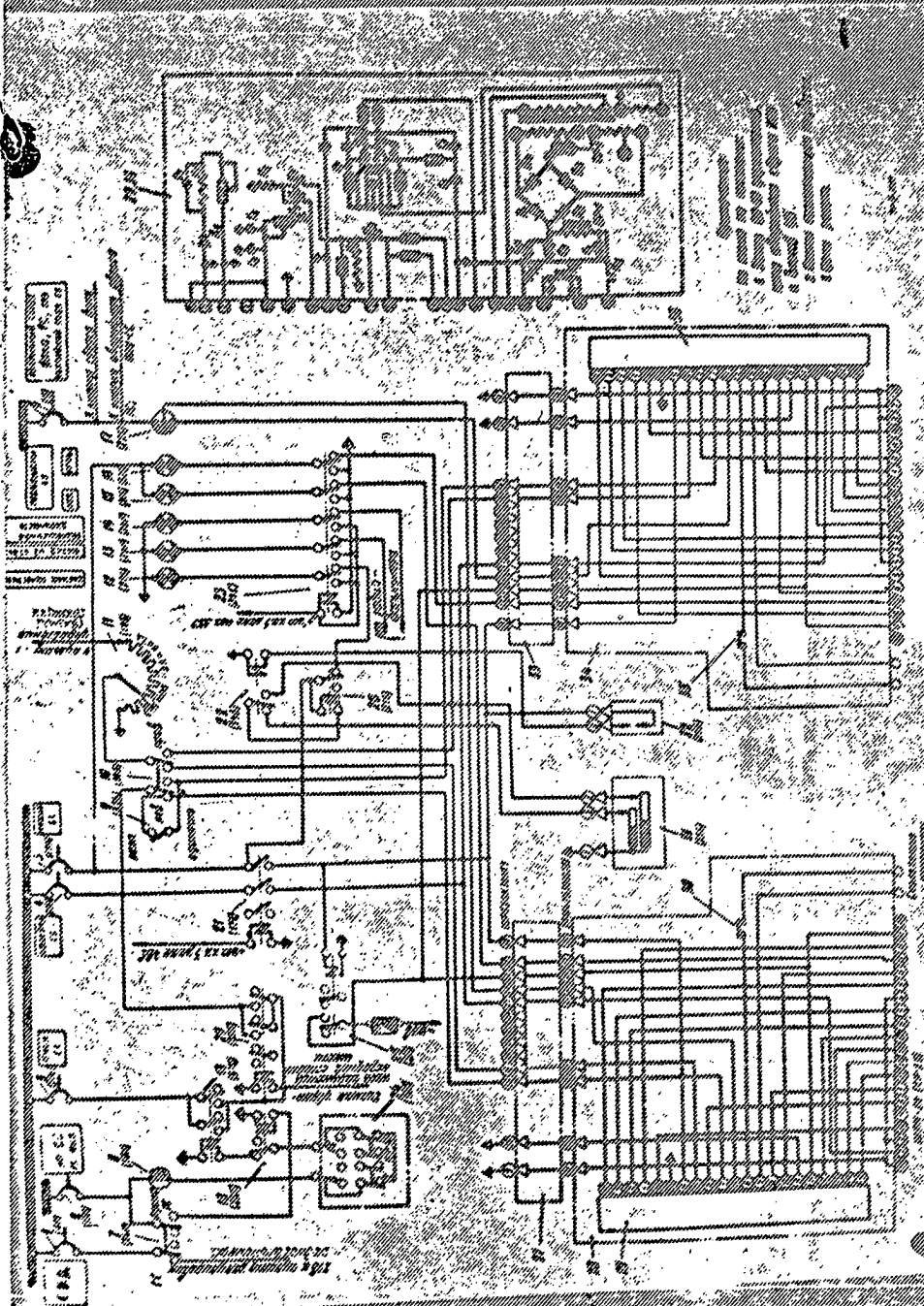


Fig. 14. Schematic Electrical Diagram of K-13 Missile Launching Control System

85

S-E-C-R-E-T

50X1-HUM

Fig. 14. Schematic Electrical Diagram of K-13 Missile
Launching Control System

1- Range-only radar circuit breaker (AZS); 2- master AZS for armament installation control circuits; 3- AZS for K-13 missile launching circuits; 4- AZS for missile warming circuits; 5- AZS for missile filament circuits; 6- AZS for circuits of pylon emergency jettison and K-13 missile emergency launch; 7- mode switch for range-only radar and firing circuits; 8- firing button; 9- missile launching switch "Salvo-Single"; 10- separate missile launching selector switch; 11- lock-on signal loudness control; 12- signal light for missile launching ban due to overload; 13- "Withdraw from Attack" signal light; 14- permissible range signal light; 15 and 16- signal lights indicating presence of missiles on launching mechanisms APU-13; 17- emergency missile launching button; 18- circuit switching relay for gun firing and missile launching control; 19- missile launching circuit relay; 20- relay for locking missile and rocket launching with I.G. position; 21- high-current cut-out relay (blocking); 22- switching relay for overload signal circuits; 23- relay for monitoring condition of signal lights; 24- sight selector switches panel; 25- converter PO-500A relay for missile power supply; 26- overload signal relay; 27- left pylon BDZ-60-21U; 28- aviation launching mechanism APU-13 on left pylon; 29- electrical launching device EPU-13 of left APU; 30- end switch in left APU (with safety pin removed); 31- overload indicator MP-28A; 32- altitude signalling device VS-14500; 33- right pylon BDZ-60-21U; 34- aviation launching mechanism APU-13 on right pylon; 35- end switch in right APU (with safety pin removed); 36- electric launching device EPU of right APU.

In single missile launching, selector switch "Salvo-Single" 9 (33B) is placed in the position "Single", while the separate missile launching selector switch 10 (36B) is placed in position "Left" or "Right" depending on which of the two missiles is to be launched.

By placing selector switches "B-S" and "NR-30-RS" on sight selector switch panel 24 (16P) in positions "S" and "NR-30", respectively, and the operating mode selector switch 7 (24P) in position "SS", the launching circuits will be completely ready for the launching process.

When firing button 8 (18P) on the control stick handle is pressed, the aircraft line voltage is fed through circuit breakers of "NR, SS, RS, FKP" 2 (17P), through the contacts of the sight panel switches 24 (16P) and the relay contacts of the fire control circuits 18 (26P) to the relay coil of the missile launching circuits 19 (37B). Relay 19 triggers and + 27 volts

passes through its double contacts to the launching circuits through circuit breaker "Missile Launching" 3 (30B) (as was noted, this circuit breaker is turned on approximately 5 minutes prior to launching.) Further, voltage is fed from circuit breaker "Missile launching" through the L.G. interlock relay 20 (20B) to the separate missile launching selector switch 10 (36B). Depending on the position of the switch, voltage is fed through it and terminals "18" of plugs ShR-55 and 2RM to terminal "7" of either the left or the right EPU-13 attachment. At the same time, voltage is fed through EPU-13 (resistor R_8 and terminals "8" plugs EPU and SR-20) the firing cartridge of the missile solid-propellant hot-gas generator (PAD). The igniting filament fires the PAD grain; pressure developed by burning gases starts the missiles turbogenerator. The EPU resistor R_8 limits the current in case of a short-circuit in the firing cartridge. Simultaneously with the actuation of PAD, electrical launching mechanism relay K_3 triggers (voltage is fed to the relay coil through the same terminal "7" of EPU) and feeds + 180 volts through normally open contacts K_3 and terminals "15" of EPU and SR-20 plugs from the EPU power supply to the missiles rudder trim neutralization circuit at the same time uncaging the head by the opened contacts of K_3 (breaking the circuit between terminals "13" and "14" of the shear plug).

[p 86]

Voltage from the missile turbogenerator output is fed through terminal "3" of the shear plug to the electrical launching mechanism EPU-13 to the generator output voltage indicator.

After the turbogenerator achieves the rated output, the power supply for the missile heads is switched over from aircraft power sources to the missile turbogenerator in the following manner: as soon as the turbogenerator achieves rated conditions, i.e. when the generator voltage reaches 140 ± 2 v, relay K_7 of the indicator triggers closing the K_2 relay circuit. Relay K_2 is self-operating. The missile supply circuits of $+180$ v and $+25$ v (from aircraft network) are broken by the opening of K_2 contacts. Simultaneously, through the closed contacts of K_2 and resistors R_{20} and R_{21} of EPU-13, through end turnoff safety switch 35 (or 30) of APU-13 and the sliding contacts, a voltage of $+27$ v is fed from the circuit breaker "Missile Launching" to the firing cartridge circuits of the rocket motor and missile proximity fuse ignitor battery warmer. When the power-propellant motor ignites, the missile slides off the APU-13 launching mechanism in homing condition, and one of the "Missiles Attached" lights goes out. [p 87]

In order to launch both missiles in a salvo, selector switch "Salvo-Single" 9 (36B) must be placed in position "Salvo." Then, regardless of the position of the separate launching selector switch 10 (36B) "Left" or "Right", $+27$ volts will be applied through it to both the left and right missiles, and the above described launching process will take place simultaneously for both missiles.

Operation of emergency missile launching circuit

Emergency missile launching is done only by salvo, apart from the normal launching circuits, by means of the button with the sign "emergency Missile Launching."

When button 17 (22B) "Emergency Missile Launching" is pressed, + 27 volts is applied to the firing cartridge circuits of the rocket motor and the proximity fuse battery warmers of both missiles through circuit breaker "Emergency Drop, Fuel Tank, Rockets, APU. Emergency Missile Launching" 6 (9B), the contacts of button 17, terminals "28" of plugs ShR-55 and 2RM, terminals "17" of EPU, and further through resistor R₂₀, R₂₁ of EPU-13, through safety and turnoff switches 35 and 30 of APU-13, and through the sliding contacts of APU-13 and the missiles.

[p 88]

The missiles slide off the launching mechanism guides as unguided missiles, and the missile attachment signal lights go out.

CHAPTER III

UNGUIDED ROCKET INSTALLATIONS

Aircraft installations of unguided rockets are intended for the carrying, aiming, and launching of unguided rockets (RS) in the direction of the flight.

The unguided RS installations include:

- two underwing universal pylons BDZ-60-21U (describing in chapter II);
- two 16-barrel pads UB-16-57U for carrying and launching S5M or S5K rockets;
- sight installation ASP-5ND connected with range-only radar SRD-5MK, angle of attack and side slip indicator DUAS-8M, and infrared viewer SIV-52; in launching unguided rockets, the sight operates automatically;
- rocket launching electrical control system which includes: two control devices PUS-36D which distribute and supply current pulses in rocket launching; manual (in the cockpit) and relay control equipment; light signalling; and aircraft electrical networks.

1. INSTALLATION AND ATTACHMENT OF UNGUIDED ROCKETS

Unguided rockets are attached to pylons under the wings symmetrically, on the right and left, at a distance of 1975 mm from the aircraft's centerline (see fig. 4):

- attached to each pylon is one UB-16-57U pod for 57 mm rockets. [p 90]

Each attached pod holds sixteen rockets. The coordinates of the pod's center are: 6544 mm from the forward edge of the fuselage (along the axis of the middle carrying lever of pylon lock DZ-57) and 491.5 mm down from the structural horizontal line of the fuselage. The longitudinal axis of the pod is inclined downward at an angle of $1^{\circ}30'$ with respect to the longitudinal axis of the fuselage.

In order to attach pods UB-16-57U, the supports with small bases (for APU) must be removed from the pylons and replaced with supports with 120 mm and 108 mm bases:

Attachment of pod UB-16-57U is shown in fig. 15

2. SIXTEEN-BARREL LAUNCHING POD UB-16-57U

FUNCTION

The sixteen-barrel universal launching pod UB-16-57U is intended for carrying and launching unguided rockets S-5M and S-5K from the aircraft.

Technical data

Caliber	57 mm
Total number of rockets carried simultaneously in one pod	16
Rocket launching control	electrical from the aircraft network; voltage = $27 \pm 10\%$ v
Types of rocket launching	single or in series with time intervals of not less than 50 microseconds

[p 91]

Weight of the pod:

- | | |
|--------------------|--------|
| a) without rockets | 54 kg |
| b) with rockets | 117 kg |

Dimensions:

- | | |
|-------------------------------|---------|
| a) length | 1850 mm |
| b) width | 335 mm |
| c) height with suspension lug | 381 mm |

Design

Pod UB-16-57U has a streamlined shape. It consists of a body which hold sixteen tubes, forward and aft fairings, two attachment fittings, forward and aft supports, plug connectors and electrical wiring (see fig. 15).

Body 13 (fig 15) is made of magnesium alloy. Fairings are located at the forward and aft ends of the body.

The forward fairing (15) has sixteen openings to accomodate the front ends of the tubes (16). It is attached to the body by bolts. The aft fairing (10) is removable and is attached by means of lugs which engage the lugs of the body when the fairing is turned around its longitudinal axis; the fairing is prevented from twisting by a stop mechanism.

In order to determine whether the aft fairing is open or closed, markings are made on it and the body with signs near them reading "open", "closed."

[p 92]

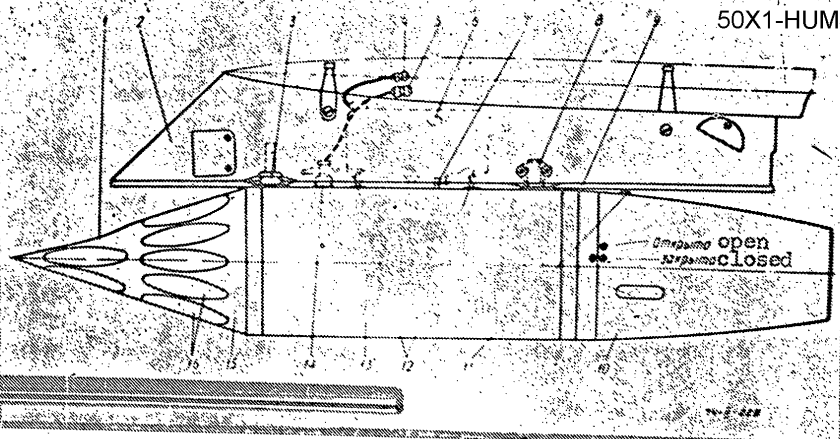


Fig. 15. Attachment of Launching Pod UB-16-57U

1. pod UB-16-57U; 2. pylon BDZ-60-21U; 3. forward support; 4. 10-terminal plug ShR-32; 5. 30-terminal plug ShR-55; 6. lock DZ-57; 7. rod of locking and signaling mechanism (MBS); 8. rear support; 9. pylon adapter beam; 10. rear fairing of pod; 11. rear fairing lock shoe; 12. yokes (eye bolts) for pod attachment; 13. body of pod; 14. 30-terminal plug 2RM; 15. forward fairing; 16. barrels of pod.

The pod is attached to the pylon lock BDZ-60-21U by means of two yokes (12), while the forward (3) and aft (8) supports are matched with the pylon supports. The supports limit lateral or longitudinal movement of the pod.

Each fitting of the attachment consists of a yoke (eye bolt) socket, bushing, nut, keys, and balls. The bushing is retained in the socket by means of balls and when rotated, the yoke moves vertically, while turning of the latter is prevented by keys placed in its grooves and in grooves of the socket.

Sixteen tubes are installed in the body; each serves to launch one rocket and is equipped with a rocket holder. The tube is open in the rear for escape of gas when the rocket is launched. This reduces technical dispersion of rockets as a result of a decrease in the reactive force of gas pressure as the rocket emerges through the slanting tube nozzle in the cone of the forward fairing.

The rockets are secured inside the tubes by holders which, in turn, are secured by the diaphragm of the aft fairing. Each holder has welded on to it special longitudinal catching strips to catch the bottoms of the rockets.

Rocket launching is accomplished by an electrical system, installed in the pod, consisting of the following elements: one thirty-terminal plug connector 2 PM (14, fig. 15), which connects the electrical circuits of the pod with those of the pylon; wiring and female sockets installed on the back end of the body of the pod for connection of rocket wires through which current pulses are fed to the electric igniters of the rocket motors.

[p 94]

3. USE OF THE ASP-5ND SIGHT IN UNGUIDED ROCKET LAUNCHING

Sight ASP-5ND functions automatically in unguided rocket launching.

For the purpose of solving sighting problems, the sight is connected to the range-only radar which, in this case, operates in mode "A", feeding present target range to the sight, and to the angle-of-attack and side-slip indicator DUAS-8M, which improves sighting accuracy in launching unguided rockets by feeding angles-of-attack and side-slip to the sight. Thus, consideration of the angle of lag produced by the sight is provided not only in the function of speed, flight altitude, and target closing speed, but also in the function of angle-of-attack and angle of side-slip.

Therefore, the sight head arrester handle must be placed in position "Gyro." The sight's luminous grid in this case occupies the position necessary for precise sighting.

For information on the sight see chapter VI.

4. UNGUIDED ROCKET LAUNCHING CONTROL SYSTEM

[p 95]

The unguided rocket launching control system is electrical; it is supplied by 27 volts d-c from the aircraft network and provides for operation of the launching circuits, launching interlock with L.G., launching of rockets in a salvo, in a series of two salvos, or an automatic series of salvos until the total consumption of rockets is reached (a salvo is a simultaneous launching of rockets from the pods attached under the left and right wing), and also for signalling of pod attachment. It also provides for emergency jettisoning pods of UB (or launching mechanisms APU-13) with or without load.

The rocket launching electrical control system includes the following elements and mechanisms:

- two/control mechanisms PUS-36D installed inside the wing cantilivers in the area of the pylons between the tips of wing ribs 14 and 15;

- control instruments:

- a) manual, installed in the cockpit (circuit breakers, switches, buttons, see fig. 13);

- b) automatic (rocket launching circuit relay - pos. 41P; missile and rocket launching interlock relay with L. G. - pos. 20B, and others);

- light signal system in the form of signal lamps.

Connection of the electrical system of each UB-16-57U pod with the aircraft electrical launching control circuits is achieved by way of the following connector plugs:

- ShR-56, connecting the pylon with the wiring inside the wing;
- 2RM, connecting the pod with the pylon

[p 96]

Supply of current pulses to the electrical igniters of powder propellant motors is provided from female plugs through the rocket cords in the UB-16-57U pods.

A. Control mechanism PUS-36D

Function

Control mechanism PUS-36D is designed to produce a series of 36 electrical current pulses in a multi-channel system and their distribution to circuits as required in a definite order.

Both PUS-36D mechanisms in the aircraft are intended to provide a series of 16 working pulses each according to the number of unguided rockets installed in each UB-16-57U pod. The components are not connected to all 36 lamels of the external row of the distributor but only to the 16 odd ones from 1 to 31 (in the schematic drawing of fig. 19 these lamels are marked with heavier numbers placed near the pin of the plug); the remaining lamels of the exterior row are blanks, and the pulses are also inactive.

Basic technical data

Operating voltage	27 v $\pm$ 10%	
Current consumption	not more than 1.6 a	
Time interval between working pulses (under normal conditions)	50 μ sec $\pm$ 10%	
Pulse duration	7 - 15 μ sec	[p 97]
Maximum number of working pulses	16	

Operating conditions:

- a) series of 16 working pulses
- b) series of 2 working pulses
- c) series of 1 working pulse

life-time of PUS-36D--1000 actuations;
of those:

a) blank actuations	650
b) actuations with load (combat)	350

(Each pressing of the firing button is considered one actuation of PUS-36D regardless of the mode of operation of the mechanism)

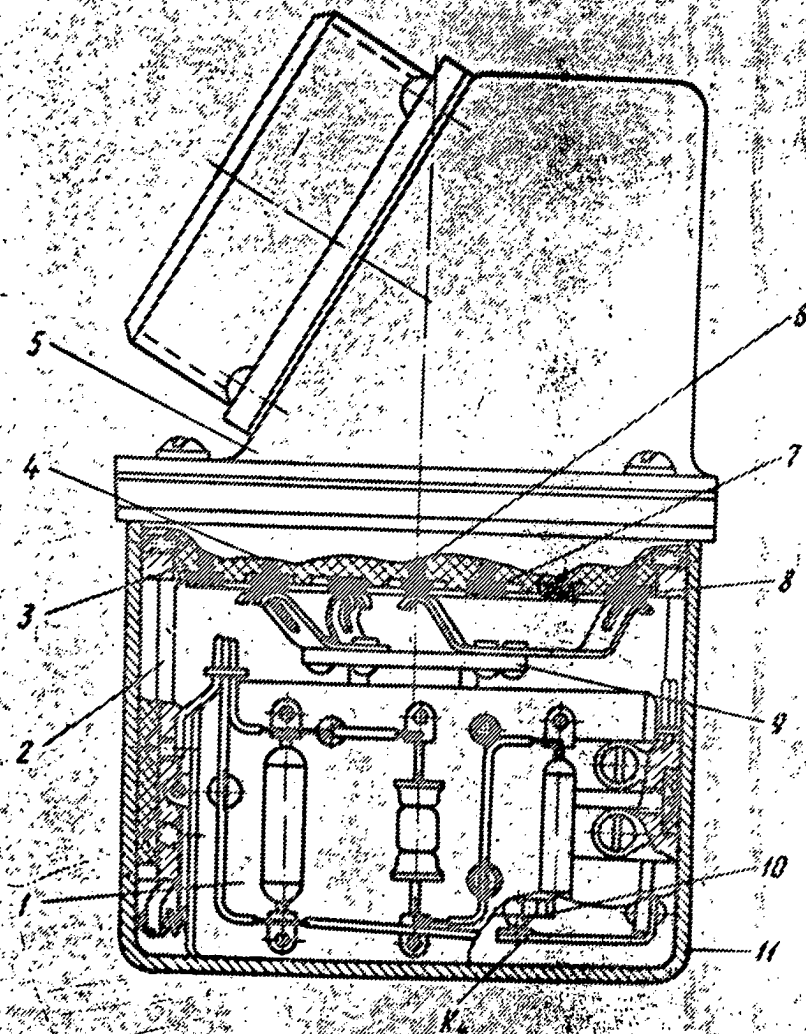


Fig. 16. General View of Control Instrument PUS-36D

1. electromagnetic relay; 2. base; 3. distributor; 4. lamels of inside row; 5. housing with plug connector; 6. contact rivet; 7. contact ring; 8. lamels of outside row; 9. sliding contact with brushes; 10. ratchet wheel contact; 11. cover; Kh. contact in signal light circuit of instrument's null (initial) position.

Operating temperatures range	from -60°C to +60°C
Altitude limit	25000 m
Dimensions	70 x 70 x 117 mm
Weight (without plug connector)	0.450 kg

Design and operation of the mechanism

The PUS-36D control mechanism (fig. 16, 17, 18) is an electro-mechanical device, the basic parts of which are: base (2) (fig. 16), electromagnetic relay (1), distributor (3) cover (11), and housing with plug connector (5).

The electromagnetic relay is intended for moving the slider (9) with brushes over the lamels (4, 8) of distributor (3), connecting the brushes with the source of power, and for control of contacts K1, K2, and K3 ensuring a pulse mode of operation of the mechanism. [p 98]

The distributor is made in the form of a round plate with lamels installed on it. The lamels are arranged in outside and inside rows (4, 8, fig. 16). In the center of the distributor are contact rings (7) and rivets (6) (fig. 16) (or 4 and 3 in the diagram of fig. 19). Current flows from the ring to the lamels of the inside row (through brush #2) and from the rivet to the lamels of the outside row (through brush #1).

The time of the interval is regulated by adjusting resistor R (fig. 19).

In the initial position (see fig. 19), brush #1 must be over the first lamel of the outside row, and brush #2 -- in the interval between lamels of the inside row; contact K1 is closed with contacts K2 and

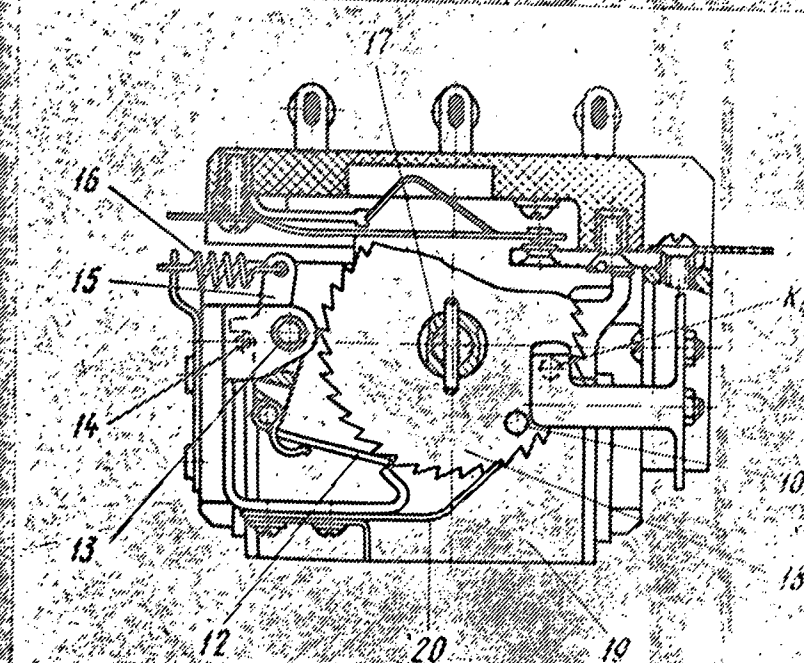


Fig. 17. Electromagnetic Relay PUS (side view)
(position numbers identical to figures 16 and 18)

10. contact of ratchet wheel; 12. catch; 13. rocker axle; 14. link;
15. rocker; 16. spring; 17. spindle of ratchet wheel; 18. ratchet
wheel; 19. electromagnet coil; 20. spring.

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S-E-C-R-E-T

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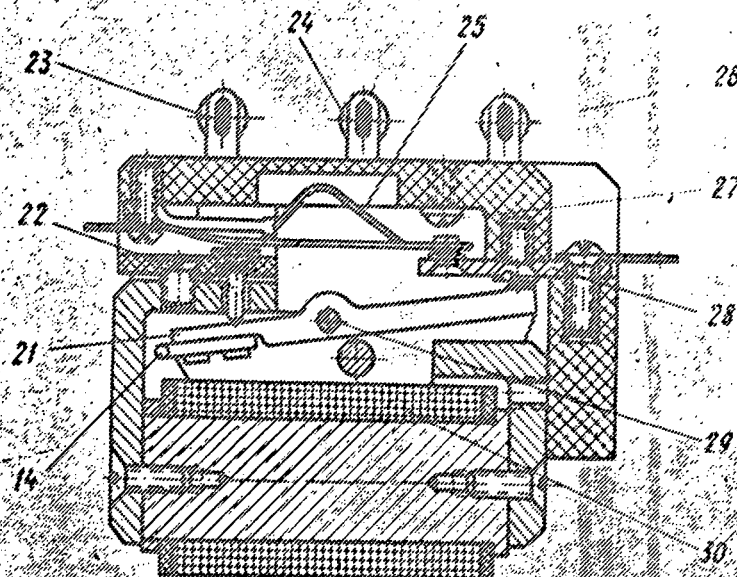
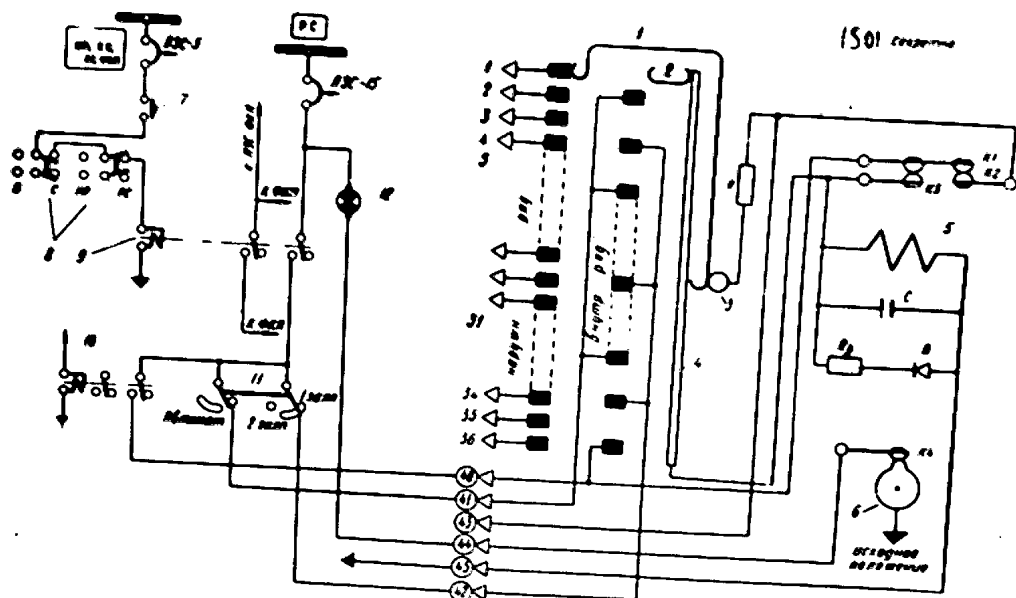


Fig. 18. Cross-Section View of Electromagnetic Relay
(position numbers identical to figures 16 and 17)

14. link; 21. anchor; 22. push rod; 23. capacitor; 24. germanium diode;
25. three-leaf contact spring; 26. resistor; 27. support; 28. plate
with contacts (K2, K3); 29. anchor axis; 30. relay coil.

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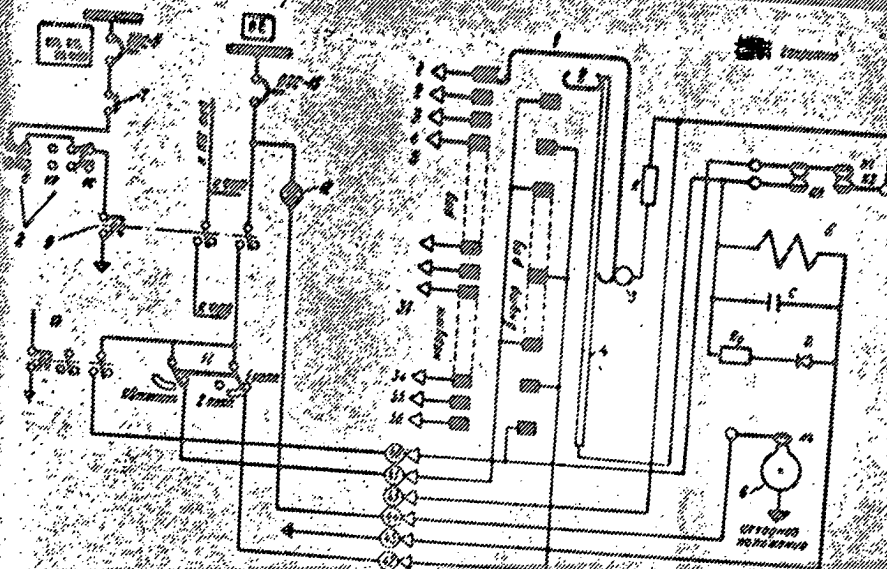


Фиг.19. Принципиальная электрическая схема ИС-367

1 - петля В 1 (переходит на клеммы внешнего ряда распределителя); 2 - петля В 2; 3 - зажимка контактная; 4 - кольцо контактное; 5 - обмотка реле; 6 - хрупкое колесо; К1, К2, К3 - контакты контактной группы; К4 - контакт в цепи сигнальной линии нулевого (исходного) положения прибора; R - регулируемое сопротивление; R₂ - сопротивление 2 Ом; C - конденсатор; В - германиевый диод; 7 - кнопка стрельбы; 8 - переключатель стрельбы и реле оружия; 9 - реле пуска РС и выключения СЛ; 10 - реле включения пуска СС и РС по пуску; 11 - переключатель заливов РС; 12 - линия оптимизации исходного положения ИС-367.

50X1-HUM

1. brush #1 (sends pulses to lamels of outside row of distributor);
 2. brush #2; 3. contact rivet; 4. contact ring; 5. relay coil;
 6. ratchet wheel; K1, K2, K3 - contact group contacts; K4 - contact
 in signal light circuit of instrument's null (initial) position;
 R - control resistor; R₂ - 2 ohm resistor; C - capacitor; B - germanium
 diode;



7-firing button; 8-firing and armament type selector switches;
 9-rocket launching and FKP switch-on relay; 10-missile and
 rocket launching - L.G. blocking relay; 11-rocket salvo selector
 switch; 12-PUS-36D initial position light.

K3; contact K4 is closed with the contacts of ratchet wheel (6); here, signal light (12) must be burning indicating that PUS-36D is in the initial position.

The operating conditions of PUS-36D are controlled by the rocket salvo selector switch.

When operating in series of a single working pulse, salvo selector switch (11) is turned to position "1 salvo." When firing button (7) is pressed, current is fed from the aircraft network through terminals 41 and 42 of the plug connector to all lamels of the inside row of the distributor and through terminal 40 of the plug, contacts K1 and K2, resistor R, brush #1 (to the first lamel of the outside row), and from there to the first component (rocket). Simultaneously, positive current of the aircraft network is fed through contacts K1 and K3 to the relay coil (5). The relay triggers and pulls up the armature (21) (fig. 18). At this point the armature's right shoulder moves downward while the left shoulder with link (14) moves upward and turns rocker (15) on its axis (13) (fig. 17). The rocker stretches the spring (16) with its upper arm, while with its lower arm it leads catch (12) toward the ratchet wheel until it catches the next tooth of the wheel. While the catch moves, the ratchet wheel is prevented from going in a reverse direction by spring (20).

[p 102]

As the armature turns, its left shoulder moves push rod (22) (fig. 18) whose upper end presses against three-layer laminated contact spring (25); as a result, the spring is shifted towards stop (27) and breaks the K1, K2 and K1, K3 contact circuit; flow of current to the armature core and to the first lamel of the outside row ceases.

The armature is returned to its initial position by the action of spring (16) (fig. 17), while catch (12) turns the ratchet wheel one notch and moves brush # 1 to the second lamel of the outside row and brush # 2 to the lamel of the inside row (sliding contact (9) with brushes (fig. 16) turns together with the ratchet wheel). Contact spring (25) shifts and closes contacts K1, K2 and K1, K3. The aircraft network positive current is fed to the second (blank) lamel of the outside row and through the contact pair K1, K3 to the coil of relay (5) (fig. 19); simultaneously, positive current is fed to the relay coil from the inside row lamel through brush # 2 and distributor contact ring (4). The relay again triggers and breaks contacts K1, K2 and K1, K3; current flow to the second lamel ceases while current from the inside row lamel continues through brush #2 to the coil of relay (5). The armature remains pulled up while the firing button is held.

[p 103]

When the button is released, current to the relay coil ceases. The armature is returned to its initial position by spring (16), brush # 1 moves to the third lamel of the outside row, and brush # 2 -- to a position between lamels of the inside row. Contacts K1, K2 and K1, K3 close.

In case of repeated pressing of firing button, a current pulse will be fed through brush # 1 and the third lamel of the outside row to the second component (rocket), and so on.

After eighteen consecutive pressings of the firing button, the mechanism returns to its initial position (light (12) goes on as the button is released for the last time). Sixteen of these pressings are live, providing a flow of current pulses to pod UB-16-57U, while the last two are required to bring the mechanism back to its initial position.

When operating in series of 2 working pulses, the salvo selector switch is turned to position "2 salvo." When the firing button is pressed, positive current from the aircraft network flows through terminal 42 of the plug to only the even numbered lamels of the inside row. The mechanism sends 2 working pulses with a time interval between them of 0.05 seconds and then stops, since the relay coil becomes energized by a voltage through the first even numbered lamel of the inside row. With the ninth consecutive pressing of the firing button, the mechanism returns to its initial position, sending all 16 working pulses in series of two; of these, 8 pressings are live while the last one returns the mechanism to its initial position.

[p 105]

When using a series of 16 working pulses, the salvo selector switch is turned to position "Automatic." When the firing button is pressed, positive current from the aircraft network is fed through terminal 40 of the plug to only the last lamel of the inside row. The mechanism sends all 16 pulses at time intervals of 0.05 seconds and stops after passing over all 36 lamels.

When the button is released, the mechanism returns to its initial position; lamp (12) lights up. To ensure that all 16 pulses have been sent, the firing button should be kept pressed not less than one full second (and not longer than 1.5 seconds).

B. Control Instruments and Signal Lights of Unguided Rockets

Launch Control System

Arrangement of control instruments and signal lights in the aircraft cockpit is shown in figure 13. Below is a list of equipment pertaining directly to the control of unguided rocket launching. The control instruments are placed as follow:

On the front right panel:

- AZS-10 "RS" ("Rockets") (pos. 14B). This AZS (circuit breaker) feeds current from the aircraft network to:

- a) lights indicating initial position of PUS-36D mechanisms;
- b) electromagnetic relay and lamels of PUS-36D mechanisms in case of attachment of pods UB-16-57U.

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Hence, the rocket launching circuits are supplied through this AZS

- AZS-5 "FKP" ("Gun Camera") (pos. 19P). This AZS sends current to the gun camera control circuits when launching unguided rockets and firing the gun.

- Two signal lights (green) "Zero Position of Rockets, left-right" (pos. 12B, 13B).

They signal that the PUS-36 control mechanisms are in initial position. (which is necessary in order to fire the first rockets).

On the right rear electrical panel:

- AZS-5 "NR, SS, RS, FKP" ("Gun, Homing Missiles, Rocket, Gun Camera") (pos. 17P).

Through it current is fed to:

- a) range-only radar mode switch and firing circuits;
- b) the coils of firing circuit switching relays and all relays of the launching and firing circuits.

- AZS-5 "Signal podveski baka, RS, APU" ("Signal of Tank, Rockets, APU Attachment") (pos. 1B)

This AZS feeds power to lights signalling the presence of a load on pylons BDZ-60-21U.

- AZS-20 "Avar. sbros baka, RS, APU. Avar. pusk SS" ("Emergency Jettison of Tank, Rockets, APU. Emergency Missile Launching") (pos. 9B)

Through it current is fed to the emergency load jettison circuits (by pressing the rockets and APU emergency jettison drop button).

On the left panel in the cockpit:

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- Rocket salvo selector switch "RS, 1 zalp., 2 zalp. Avtomat" (Rockets. 1 salvo, 2 salvos, Automatic)" (15B). By means of this selector switch the operating conditions of PUS-36D control mechanisms are set, providing selection of the mode of rocket launching (number of salvos by each pressing of the firing button).

When the selector switch is placed in position "1 salvo", one rocket is launched from each UB-16-57U pod each time the button on the control stick is pushed.

When the selector switch is placed in position "2 salvos", each time the firing button is pressed, two rockets are launched consecutively from each UB-16-57U pod with a time interval between launchings of 0.05 seconds.

When the selector switch is placed in position "Automatic", all rockets are launched consecutively from both pods when the firing button is pressed, with time intervals between launchings of 0.05 seconds.

On the center panel below the instrument board:

- Two signal lights (green) "Podveska RS, APU" ("Attachment of Rockets, APU") (24B, 25B). They signal the presence of a load on the pylon locks of pods UB-16-57U (or launching mechanisms APU-13).

On the left panel of the instrument board:

- Button 205KS "Avar. sbros RS, APU-SS" "Emergency Jettison of Rockets, APU-Missiles" (pos. 23 B). It supplies +27 volts to the electromagnetic launching mechanisms of pylon locks DZ-57. When the button is pressed, blocks UB-16-57U are dropped from the aircraft.

[p 108]

On the sight head bracket:

- Panel with switches for sight operating mode and firing mode (pos. 16P). Through it a voltage is fed from the firing button to the launching or firing circuit actuating relays, depending on the position of the selector switches.

On the Control stick handle:

- Firing button (war button) (pos. 18). This is the common control for firing/rifled armament and launching of rockets and missiles.

On the instrument board panel:

- AZS "Obogrev PVD, chasy" "Heating of Powder Propellant Motor, Clock". It actuates the heating elements for the angle of attack and side-slip indicators DUAS.

V. Unguided rocket launching

The following equipment must be turned on prior to unguided rocket launching: .

- general circuit breaker "NR, SS, RS, FKP" ("Gun, Homing Missile, Unguided Rocket, Gun Camera") for the armament control system circuits.

- circuit breakers connecting the range-only radar and sight circuits: "Pritsel, obogrev pritsela: ("Sight, Sight Heating"), "Pritsel" ("Sight") and "SRD" ("Range-only Radar");

- AZS "Signal podveski baka, RS, APU" ("Signal of Attachment of Tank, Rockets, APU");

- AZS "RS" ("Rockets");

- AZS "FKP" ("Gun Camera"), if FKP is installed for monitoring results;

- AZS "SIV" ("Infrared viewer") if SIV-52 is installed for night conditions.

In order to connect the sight with the range-only radar, the operating mode switch of the radar and firing circuits "RS, pushka-SS" ("Rockets, Gun-Missiles") must be placed in the position "Rockets, Gun" (mode "A" operation).

[p 109]

To match the mode of operation of the sight with the armament, the sight panel selector switches must be placed in the following positions:

- switch "S - B" -- in position "S";
- switch "NR-30-RS" ("NR-30 (gun) - Rockets") -- in position "Rockets";
- switch "N-DUAS" -- in position "DUAS" (interconnection of sight with angle of attack and side-slip indicator);
- switch "Radio-Optika" ("Radio Optics") -- in position "Radio".

The handle of the arrester on the sight's head must be placed in position "Gyro".

Two signal lights "Podveska RS, APU" ("Rockets, APU Attachment") must be burning when pods UB-16-57U are attached to the pylons.

Two signal lights "Nulevoye polozheniye RS" ("Rockets Position Zero") must be burning when PUS-36D equipment are in their initial position, regardless of the presence of a load.

In flight, with pods UB-16-57U carrying S-5M or S-5K rockets the rocket salvo selector switch must be placed in one of the following positions: "1 zalp", "2 zalp", "Avtomat" "1 Salvo", "2 Salvo", or "Automatic", depending on the selected variant of rocket launching. Upon target lock-on by the range-only radar and completion of sighting, launching of rockets is carried out by pressing the firing button on the control stick handle once or by successive pressing of the button if the launching is carried out in a series of salvos.

When the firing button is pressed, voltage is sent from the aircraft electrical network to the motor igniters of the rockets, and the latter slide off the launching mechanisms.

[p 110]

G. Operation of Electrical System for Controlling Unguided Rocket Launching

A schematic diagram of the system used for the control of rocket launching and jettisoning of fuel tanks is given in fig. 20. The drawing shows both BDZ-60-21U pylons and gives the two types of attachments: the left wing and pylon diagram shows pod UB-16-57U with rockets and control mechanism PUS-36D; the right pylon diagram shows only lock DZ-57 with attached pod UB (or APU-13).

The MBS mechanisms are exposed in the diagrams of DZ-57 locks of both pylons.

All elements in the drawing are given ordinal numbers; in references, given in parentheses, are the positions according to the markings of electrical equipment specifications.

The rocket launching circuits are interlocked with L.G. position by means of relay TKYe -53PD (18), which prevents accidental launching of rockets on the ground.

Operation of electrical circuit for signalling attachment

The launching mechanisms are attached on the ground. When pods UB-16-57U (or launching mechanisms APU-13) are attached to the pylon

lock DZ-57, the mechanism's housing presses against the rod of the signalling and interlock mechanism of the DZ-57 lock pushes it up, and closes the signal system minus circuit through contacts "1" - "2" (fig. 20).

When AZS "Signal of Tank, Rockets, APU Attachment" 32 (1B) is [p 111] turned on, voltage is fed to signal lights 10 and 11 "Attachment of Rockets, APU" (24B, 25B) and further through terminals "1" of connector plugs ShR-32 of the pylons and locks and the closed contacts "1" and "2" of MBS and terminals "2" of the same plugs - to "minus." The lights go on and burn until either the launching mechanisms are dropped or the AZS is turned off.

Operation of Electrical Circuits Signalling Initial Position of PUS-36D Instruments

The initial position of PUS-36D (20, fig. 20) necessary prior to launching of the first rockets from pods UB-16-57U may and should be checked on the ground prior to attachment of the pods or loading them with rockets. For this purpose it is necessary to simulate operating conditions of launching circuits as they will occur in flight, namely:

- turn on the circuit breakers and switches as indicated in the preceding section V, "Unguided Rocket Launching", and place salvo selector switch RS 19 (15B) in position "Automatic";
- turn on AZS "Landing Gear Signal, ANO" (2S, not shown in fig. 20);
- press the push-button signal switch of nose L.G. retraction (6S, not shown in fig. 20); this will send voltage to the coil of relay 18 of the launching circuit and L.G. interlock; the relay will trigger and close the launching circuits;

- while holding the switch in, note whether lights 7 and 8 "Rocket position Zero" (12B, 13B) are burning. The signal lights will burn if the PUS-36P ratchet wheel contact and contact "K₄" are closed. If the lights are not burning, it is necessary to press the firing button 5 (18P). This will send a voltage to the electromagnetic relay of PUS-36D through the latter's terminal "40", the instrument will work through its cycle and will stop in its initial position. Signal lights "Rocket Position Zero" will light up. [p 112]

Rocket Launching Electrical Circuit Operation

The rocket launching circuits are interlocked with the position of the nose landing gear by means of relay 18 (20B). After aircraft take-off and retraction of L.G., the end (push-button) signal switch of nose L.G. retraction (2S, not shown in fig. 20) closes the circuit of the relay 18 coil; the relay triggers and, by closing the contacts, puts the rocket launching circuits in ready condition. Launching of rockets is carried out only in flight; therefore, let us suppose that all switches and AZS in the diagram of fig. 20 are turned on, as indicated in the preceding section "V. Launching of Unguided Rockets."

With launching pods UB-16-57U attached and PUS-36D instruments in their initial positions, the following are lit:

- two signal lights "Attachment of Rockets, APU" -- 10 and 11 (24B, 25B);
- two signal lights "Rocket Position Zero" -- 7 and 8 (12B, 13B).

After target lock-on and sighting, the rockets are launched by pressing the firing button 5 (18P).

a) Operation of Circuit When Launching Rockets From
UB-16-57U Pods

[p 113]

When the firing button is pressed, an aircraft line voltage of + 27 v is fed through AZS "NR (gun), H. Missile, Rocket, Gun Camera" 1 (17P), the button contacts and sight panel switches 6 (16P) to the coil of the relay connecting the gun camera and rocket launching circuits 14 (41P); the relay closes the launching circuits for "launching" and simultaneously switches on the gun camera if it is installed. At the same time, + 27 volts goes through AZS "Rockets" 2 (14B) and contacts of relay 14 (41P) to:

- rocket salvo selector switch 19 (15B)
- terminals "40" and the last lamel of the inside row of the left and right PUS-36D units through closed contacts of the rocket launching and L.G. interlock relay 18 (20B)

If, at the same time the rocket salvo selector switch is placed in the position "Automatic", the PUS-36D mechanisms will produce 16 working pulses: current is fed from PUS terminal "40" through vibrating contacts K_1 , K_2 , brush # 1, and lamels "1-31" of the outside row of PUS and further through terminals "1, 2, 13, 14, 15, 19, 20, 21, 22, 23, 3, 4, 5, 6, 7, 8" of connector plugs ShR-55 and 2RM of the pylons and pods 25 -- to electrical igniters "1 to 16" of the powder propellant rocket motors, which have a common minus side through terminals "9" of the pods and pylons. The rocket motors are ignited one by one at the time intervals of 0.05 seconds, and all rockets are launched in turn from the tubes of the UB-57U pods.

When the rocket salvo selector switch is placed in position "1 salvo", [p 114] the PUS-36D mechanisms produce only one working pulse. In this case current is fed through the contacts of salvo selector switch 19 and PUS terminals "41, 42" to all lamels of the PUS inside row. When firing button 5 is pressed and relay 14 operates, the aircraft plus voltage will pass through relay 18, terminals "40", contacts $K_1 - K_2$, brush # 1, and PUS lamel "1" to the electrical igniter of the powder propellant motor of rocket "1" in the left and right UB-16-57U pods. Rockets "1" will be launched. At the same time, the PUS relay will operate and move brushes ## 1 and 2 and then stop (see description of PUS-36D operation). In order to launch the next two rockets, the firing button must be released and then pressed again. To launch all rockets, the button must be pressed and released 16 times.

When the rocket salvo selector switch is placed in position "2 salvos" the PUS-36D mechanisms produce 2 working pulses. When the firing button is pressed, current is fed from the selector switch through terminal "42" of PUS to the even lamels of the inside row. After sending two pulses to the electrical igniters of rockets "1" and "2" in each pod with a time interval of 0.05 seconds, the mechanism stops. Thus, four rockets will be launched in two salvos by a single pressing of the firing button. In order to launch all rockets, it is necessary to press the button eight times, releasing it after each pressing.

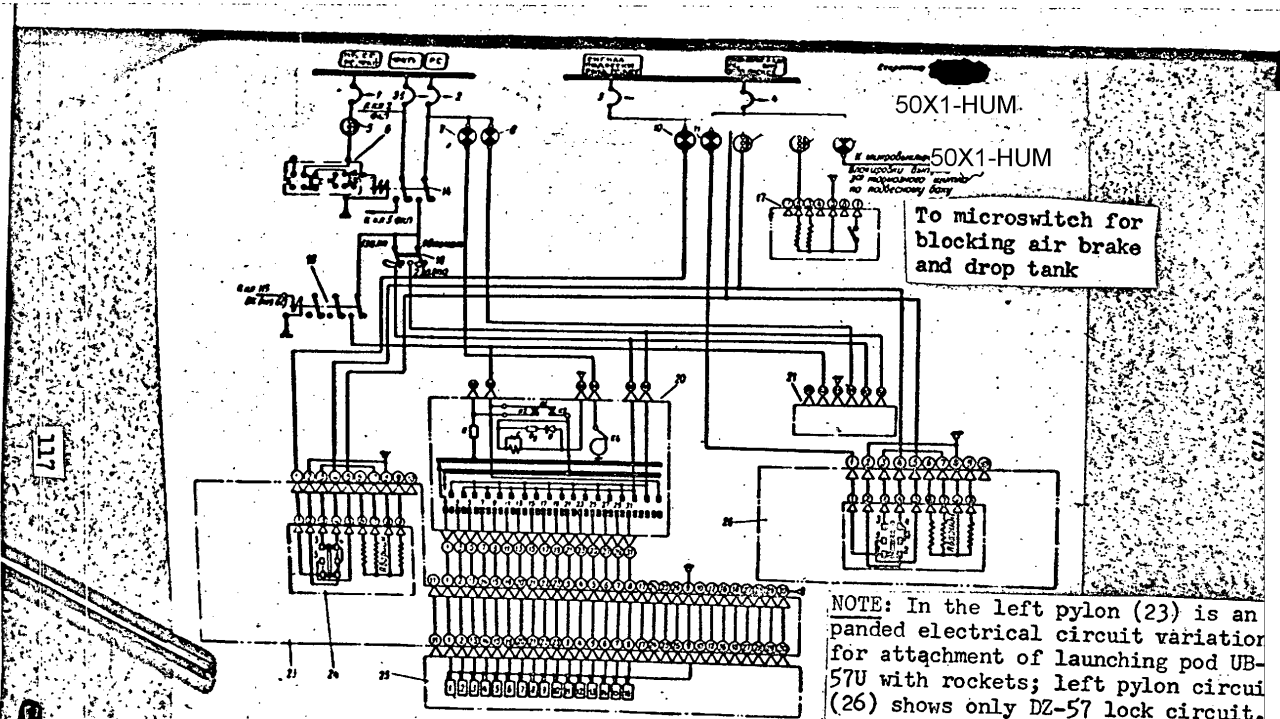


Fig. 20. Schematic Electrical Diagram of Launch Control of Un-guided Rockets and Jettisoning of Drop Fuel Tank.

Схем. 20. Принципиальная электрическая схема управления пуском неуправляемых ракетных снарядов и сбрасыванием подвесного топливного бака.

Figure 20. Schematic Electrical Diagram for Control of
Unguided Rocket Launching and Fuel Drop Tank

1. Main circuit breaker (AZS) for armament installations control (17P);
2. AZS for rocket launch circuit (14B); 3. AZS for light circuit, signalling presence of load on pylon (1B); 4. AZS for emergency jettison of pylon loads and emergency launch of K-13 missiles (9B); 5. firing button (18P);
6. sight switch panel (16P); 7. readiness (initial position) signal light for left PUS (13B); 8. readiness (initial position) signal light for right PUS (12B); 10. Light signalling presence of load on left pylon lock (24B); 11. light signalling presence of load on right pylon lock (25B);
12. button for emergency jettison of load (23B); 13. button for jettison of drop tank (10B); 14. circuit relay for RS launch and FKP (41P);
17. lock BDZ-56-Ye for attachment of drop tank (5B); 18. relay for interlocking rocket and missile launch with L.G. position (20B); 19. RS salvo switch (15B); 20. control instrument PUS-36D in left wing (16B); 21. control instrument PUS-36D in right wing (17B); 23. left pylon BDZ-60-21U;
24. attachment lock DZ-57 in left pylon (40B); 25. pod UB-16-57U; 26. right pylon BDZ-60-21U; 30. light for signalling attachment of drop tank (7B);
31. AZS for FPK (gun camera) circuit (19P).

Operation of Electrical Circuit for Emergency Jettison of Rockets

(p 117)

Prior to carrying out an emergency jettisoning of UB-16-57U pods with or without rockets (or launching mechanisms APU-13 with or without missiles), the circuit breaker (AZS) "Emergency Jettison of Tank, Rockets, APU. Emergency Launching of Missiles" 4 (9B), must be switched on.

The load is jettisoned by pressing the button "Emergency Jettison Rockets, APU-Missiles" 12 (23B). In this case voltage is fed through AZS (4), the button contacts, terminal "4" of plug ShR-32, closed contacts "4-3" of DZ-57 lock signalling and interlock mechanism (24), and connector plug ShR-32 terminals "3" and "7" to the emergency coil of the electromagnetic jettison mechanism of the locks of both pylons; the locks open and the pods (or launching mechanisms) are jettisoned from the aircraft.

After jettison, the rod of the interlock and signalling mechanism is lowered (by spring action) and opens contacts "1-2" of the attachment signal circuit. Signal lights "Attachment Rocket, APU" go off.

Simultaneous drop of pods (or APU-13 launching mechanisms) from the locks of the left and right pylons is provided by the operation of the interlock and signalling mechanism (MBS) and the interlock circuit. As was previously noted, with pods attached, the minus circuits of the emergency coils of the lock release mechanisms are closed by contacts "4-3" of MBS. If in emergency jettisoning one pod separates from the pylon while the other sticks, the MBS rod, when lowering, will open contacts "1-2" "4-3" and close contacts "5-6" of the interlock circuit.

At the same time the aircraft network voltage through AZS "Emergency Jettison Tank, Rockets, APU" 4 (9B), ShR-32 plug connector terminal "5", closed contacts "5-6" of the interlock mechanism, and terminals "4" of both ShR-32 will be fed to the still closed MBS contacts "4-3" of the other lock and through them to the release mechanism emergency coil of that lock. The lock will open and the pod will be dropped.

[p 118]

The MBS mechanism works in exactly the same manner in the event of an accidental drop of a load from one of the pylons, ensuring simultaneous jettisoning of the loads (pods UB or launching mechanisms APU).

CHAPTER IV

[p 119]

DROP FUEL PYLON INSTALLATION

AND TANK JETTISON CONTROL SYSTEM

1. Drop Fuel Tank Pylon and Its Firing Mechanism

For attachment and jettisoning of a drop fuel tank, a pylon is installed on the aircraft on which are installed a lock for carrying the tank and firing mechanisms for firing (pushing away) the empty tank downward from the aircraft.

The pylon is mounted under the fuselage in the aircraft's centerline in the area between frames 15 and 21 and is attached to the lower panel of the fuselage by forward and aft coupling bolts (3 and 11, fig. 21) which fit into sockets of the panel located at frames 16 and 20. First, the couplings bolts are installed in the sockets and secured by nuts (38) with external threads; then the pylon is fitted over the coupling bolts and tightened with nuts and lock nuts (36) and (35).

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S-E-C-R-E-T

50X1-HUM

The pylon is a beam of rectangular cross-section with front and rear fairings. Its body is made of cast "Electron." Installed inside the pylon are: fuel intake adapter line (1) connected with the tank and fuel system lines by telescopic joints; pressure adapter line (10) with vacuum valve; tank attachment lock BDZ-56E (5) with electromagnetic release; microswitch (13) for indicating tank attachment and interlock with the lower air brake; tank separation charge mechanisms (9) and (4); and supports (2) and (12) which fit into the matching tank supports and prevent shifting of the tank. [p 120]

On the outside of the pylon are located a small inspection door (34) which provides access to the firing mechanism (9), a small round window for checking the security of the lock, and plug connector (7) for connection of the pylon electrical system with the electrical circuits of the aircraft. The small inspection door is attached by hinges and has locks.

The pylon firing mechanisms include a charge-driven piston mechanism (9), a pusher mechanism (4), spring release mechanism (6), and its stop (16).

The piston mechanism represents a steel cylinder installed horizontally in yoke brackets of the pylon beam. At one end, placed inside the cylinder and secured by an end nut is the breech, and at the other end - a pipe nipple with a cone-shaped trap. The cavity of the cylinder is loaded with explosive charge PK-ZM-1. The nipple of the piston mechanism is connected by a steel tube (made of 1Kh18N9T steel) with the nipple of the pusher mechanism cylinder, thus connecting the cylinders of the firing mechanism and the pusher mechanism.

The firing mechanism breech consists of a body with a double percussion pin (23) and the firing spring located inside of it. The firing pin rod has a slot with a roller (24) installed inside of it which rolls along the grooved edge of the flat check bar (22) when the latter moves.

[p 121]

The firing pin is retained in cocked position by this roller which sets into a recess on the edge of the check bar. The check bar fits into a slot in the body of the breech and is retained by tension of the firing spring transmitted through the roller of the firing pin. The check bar release force must not exceed 8 kg. The protruding end of the firing pin has an opening for a ground safety-check pin (32) which acts as an additional safety measure; the pin extends through the opening in door (34).

The ground safety check pin (33) has a red flag attached to it which can be easily detached in all cases when it is necessary to open the door without removing the pin.

The head of the breech has on it a small lug (not shown in fig. 21) to which the release fork (21) may be attached by means of a marine bolt after the mechanism has been cocked prior to attachment of the tank.

The pusher mechanism is a vertically installed cylinder which has in its upper part a pipe nipple and in its lower part, an end nut (40). Placed inside the cylinder is a "pusher" in the nature of a hollow

piston with an externally threaded shaft. A shearing washer (28) is slid over the shaft and is held between the pusher piston and nut (39) screwed on to the shaft. The assembled pusher is placed inside the cylinder and secured by end nut (40) which presses the edges of the washer against the end of the cylinder.

[p 122]

After the tank has been installed, the opening of support (15) screwed onto the tank and the opening of the pusher shaft are superimposed, and the support and shaft are connected by pin (29).

The spring release mechanism serves to pull the check bar out of the breech and release the firing pin. The spring release mechanism consists of pull rod (17) suspended on a rocker (19); angle rocker (20) which cocks the mechanism by the turning of its axle; fork (21) connected by a marine bolt with check bar (22) of the breech, and spring (18) installed on the pull rod and compressed between the shoulder of the pull rod and the bracket of stop (16). The fork, the angle rocker, and the pull rod are connected to each other by swivel joints.

The pull rod has a square end which fits inside the stop bracket. It also has a slit with a sloped side for the stop.

Stop (16) is a shaft placed in a bracket with a socket. The shaft is pushed down by the constant pressure of its spring. The upper end of the shaft is flat and is cut on a slant for retaining the pull

rod. The lower end of the shaft faces the carrying lever of the tank carrier lock; when the lever turns (when the tank is being attached), it comes into mechanical contact with the shaft and pushes it upward. If the pulling rod (17) is cocked, the stop enters its slot and retains it in this position.

[p 123]

Interaction of Parts of the Pylon Firing Mechanism During
Jettisoning of Drop Tank

Prior to attaching the tank, the charge-driven piston is loaded with an explosive charge and the breech is closed. The check bar is put in place but is not connected with the release mechanism's fork. Turning of rocker (20) axle counterclockwise cocks the release mechanism pull rod which compresses spring (18). The release mechanism's fork is connected with the lug on the head of the breech. Then the tank is attached; its supports are placed against the pylon supports (2) and (12) turning carrying lever (27) to position "locked" by the ear of eye-bolt (14) which enters the opening in the former; at the same time, stop (16) enters the slot in pull rod (17) and retains the latter. Release mechanism fork (21) is then disconnected from the lug of the breech and connected to check bar (22), while the ground safety check pin (32) and flag is placed in the protruding end of the firing pin. After this, the pusher mechanism shaft (30) is connected to the corresponding support (15) of the tank.

The ground safety check pin is removed prior to the flight.

When the drop tank is attached, the signal light with the sign "Podveska/baka" ("Tank Attachment"), turned on by microswitch (13) whose rod was moved during attachment of tank, must be burning.

[p 124]

Jettisoning the drop tank is accomplished by pressing the button "Sbros baka" ("Tank Drop"). This actuates the electromagnetic release mechanism of the pylon lock, and the carrying lever unlocks.

When the carrying lever turns (in the direction of arrow I in Fig. 21), stop (16) loses its support and is pushed downward (as indicated by arrow II) by the spring and comes out of the slot of the pull rod. The released pull rod is moved by the force of spring (18) (in the direction of arrow III) and turns cocking rocker (20) (arrow IV). The rocker's arm, by means of fork (21), pulls the firing check bar (22) from the breech (arrow V). The freed firing pin, pushed by mainspring (25), punctures the explosive charge percussion cap (arrow VI). The percussion cap ignites. Gases created by the burning of the explosive charge enter the cylinder.

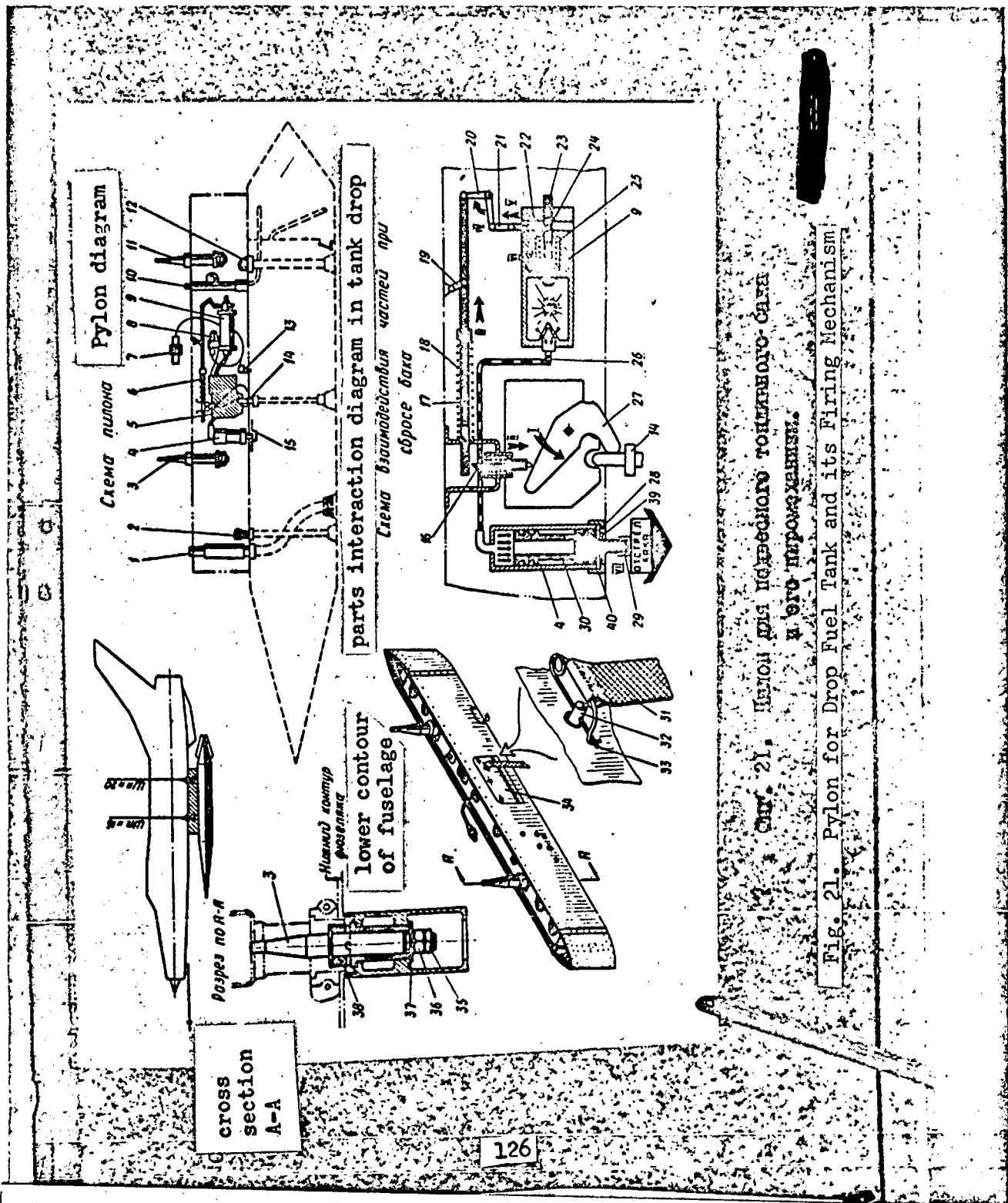


Fig. 21. Pylon for Drop Fuel Tank and its Firing Mechanism

S-E-C-R-E-T

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Fig. 21 Drop Fuel Tank Pylon and Its Firing Mechanism

1- fuel intake adapter line; 2- front support; 3- front coupling bolt;
4- pusher mechanism; 5- BDZ-56Ye lock; 6- spring trigger mechanism;
7- ShR-4 connector plug; 8- plug connector; 9- charge driven piston
mechanism; 10- pressure adapter line; 11- rear coupling bolt; 12- rear
support; 13- end actuated microswitch signalling tank attachment and
locking lower air brake release with drop fuel tank; 14- tank attachment
lug (eye-bolt); 15- support inside tank; 16- stop; 17- pull rod; 18- spring;
19- rocker; 20- cocking rocker; 21- fork; 22- check bar; 23- firing pin;
24- firing pin ball; 25- main spring; 26- tube; 27- lock carrier lever;
28- shearing washer; 29- pusher and support connection pin; 30- pusher;
31- red signal flag; 32- ground safety locking pin; 33- safety pin;
34- piston mechanism access door; 35- lock nut; 36- nut; 37- washer;
38- nut; 39- nut; 40- end nut.

of pusher mechanism (4) by way of the trap and tube. Gas pressure forces the pusher mechanism down, shearing washer (28), and is discharged from the cylinder. The force of the pusher's movement is transmitted to the tank connected with it. Thus, the drop tank is pushed downward away from the aircraft's fuselage.

NOTE: Supplied with the pylon are a fairing and plug for the adapter [p 127] fuel line for flights with installed pylon minus the drop tank. The fairing has the shape of a channel and is attached to the bottom side of the pylon by bolts screwed in to anchor nuts after the plug has been installed. Two rear attachment bolts are used: when the fairing is installed, a 32 mm long bolt is used; when the fairing is removed, an 18 mm bolt is used (bolts are 5 mm in diameter). The fairing and the plug must be removed prior to attachment of the tank.

2. Control System for Jettisoning Drop Fuel Tank

The control system for jettisoning the drop fuel tank is electrical and includes:

- electromagnetic release mechanism of pylon lock BDZ-56Ye;
- end microswitch for signalling tank attachment and lower air brake interlocks;
- circuit breakers "Attachment Signal, Tank, Rockets, APU" and "Emergency Jettison - Tank, Rockets, APU. Emergency Launching - Missiles";
- button "Tank Release";

The tank jettison control system ensures jettisoning of the tank [p 128] and interlock with the air brake. The air brake cannot be lowered with the tank attached.

Operation of Electrical Interlock Circuit for Release of
Lower Air Brake and Signalling Tank Attachment

The electrical circuit diagram is shown in figure 20.

Prior to attachment of the tank, AZS "Attachment Signal - Tank, Rockets, APU" 3 (1B) must be switched on. When attaching the tank, its body presses against the end switch rod of the drop tank and lower (3d) air brake release interlock (pos. 133M) (not shown in diagram of figure 20). The end switch contacts break the circuit of the retraction-release hydrovalve of the third air brake and close the drop tank signal light circuit. Signal light 30 (7B) goes on. Release of the air brake is not possible. When the drop fuel tank is jettisoned, the end switch rod is restored to its initial position, the hydraulic valve circuit closes, and when this valve is actuated after the tank drops, the air brake is released.

Operation of Electrical Circuit for Jettisoning Drop Tank

To jettison the drop tank, AZS "Emergency Jettison - Tank, Rockets, APU. Emergency Launching - Missiles" 4 (9B) must be switched on. Jettison is accomplished by pressing the button "Tank Jettison" 13 (10B) located on the left side of the instrument panel. Pressing of the button sends an aircraft line voltage of + 27 v to the coil of the electromagnetic launching mechanism of lock BDZ-56E-17 (5B).

The launching mechanism triggers, the lock opens, and the tank is released. Opening of the lock actuates the pylon firing mechanism, as described above, and facilitates separation of the tank by pushing it downward.

CHAPTER V

[p 130]

GUNNERY SYSTEM

The artillery armament of the aircraft consists of a fixed gunnery system intended for firing forward in the direction of flight.

The gunnery system includes:

- gun NR-30, 30 mm caliber;
- gun mount assemblies;
- ammunition feed and link removal system;
- cartridge case removal system;
- devices providing safety and stability of aircraft during fire;
- reloading system;
- fire control system;
- sighting system ASP-5ND linked with range-only radar SRD-5NK and infrared viewer SIV-52.

1. LOCATION AND MOUNTING OF GUN

Location of gun

The gun is located in the forward part of the fuselage under the cockpit floor, to the right of the aircraft's plane of symmetry, between frames 8 and 15.

Following are the gun mounting coordinates: distance from the center [p 131] of the front mount to the fuselage horizontal datum line is 382 mm; -- to the aircraft's plane of symmetry -- 390 mm; and from the axis of frame 13

in the direction of flight -- 88 mm.

The gun bore axis passes through the center of the forward mount parallel to the aircraft's plane of symmetry and at a downward angle of $1^{\circ}31'$ in relation to the fuselage horizontal datum line (see fig. 4).

Gun mounting

The gun is installed on two mount assemblies, front and rear, and in addition has a third supplementary gun barrel mount assembly.

Front gun mount assembly (fig. 22) absorbs the recoil action during fire, and is attached to the beam of the air brake housing by four 12 mm diameter bolts.

The front mount consists of the following parts: stationary upper portion of the yoke (5), hinged portion (4) of the yoke, attachment collar (8) with sectors and a set screw (9), and reloading system air valve (2).

The upper stationary part and the hinged part of the yoke are connected with each other by the air valve housing, which serves as the hinge axle.

Screwed into the valve housing is an air intake nipple for air line [p 133] connection.

The inside surfaces of both parts of the yoke and the outer surface of the attachment collar are spherical.

The attachment collar (8) is placed over the gun barrel jacket, the collar bosses are slid in behind the bosses of the jacket, and the collar is secured by lock screw (9) screwed into the notch in the jacket.

The collar is removed only in case of dismantling or replacement of the gun.

The collar (with gun) is placed inside the assembly yoke and the hinged part is secured by a clamp bolt (7).

The spherical surfaces of the attachment collar and yoke allow for the adjustment of the gun position in horizontal and vertical planes during firing.

The set screw (10), screwed in through the aperture in the hinged portion of the yoke and into an aperture in the attachment collar, prevents turning of the collar with the gun around the gun's longitudinal axis.

The rear gun mount assembly (fig. 23) is the supporting mount and is used for adjusting the gun in horizontal and vertical planes during firing.

The rear gun mount assembly is attached to the wall of frame 15 by four 8 mm diameter bolts.

The rear gun mount assembly consists of bracket (7), adjustment bushing (4), pintle with yoke (11) in which the adjustment collar (2) is installed, and spherical insert (10).

The adjustment bushing, which has female threads, is installed on the [p 134] rear mount bracket and is secured to it by nut (8) which is locked to the bushing with two pins (15).

The bushing fits tightly on the bracket but may be turned around its own axis.

Pintle (11) has a shaft with outside threads and longitudinal slits, and a ring clamp, the ends of which are drawn together by a clamp bolt (12).

A smooth conical aperture and threads are contained inside the pintle shaft for tightening the pintle inside bushing (4) by a taper bolt.

Adjustment collar (2) with a ball insert is installed in the pintle clamp and is secured in it by nut (9).

The collar's inside circumference has a 4 mm eccentricity relative to the outside circumference, which permits adjustment of the gun in all directions, but primarily in the horizontal plane by means of turning the collar.

Extension shaft (1) of the mount is screwed onto the extension shaft of the gun and secured with a lock nut (13), and is then installed together with the gun in the ball insert of the collar.

For horizontal adjustment of the gun, it is necessary to loosen clamp bolt (12) and turn adjustment collar (2) with a special wrench by four pairs of teeth on the collar, and then tighten the collar in the pintle clamp by clamp bolt (12), secure it with a wire, and seal it.

For vertical adjustment of the gun, it is necessary to release the taper bolt (5) by several turns, then, turning the adjustment bushing (4), move the pintle and thus the gun's tail shaft up or down, and then tighten the taper bolt. [p 136]

Supplementary gun barrel mount assembly (fig. 24) serves to reduce barrel vibration and, consequently, dispersion of the shells in firing. The assembly consists of the following parts: duraluminum horseshoe-shaped bracket; two serrated washers, each attached to the bracket by three bolts; stationary half-yoke and hinged half-yoke with lock pin and chain.

The barrel mount assembly is attached with bolts to special lugs of the panel in frame # 9.

Both parts of the yoke have bronze bushings installed inside them. The stationary half-yoke is attached to the bracket of the assembly by two pins with nuts. The openings for pins in the stationary half-yoke are of larger diameter than that of the pins; this allows for gun adjustment in any plane.

The yoke is slipped over the gun barrel, then installed in the bracket pins, and after completion of gun adjustment, is tightened against the serrated washers by screwing the nuts onto the pins.

The serrated washers are pressed into the yoke's body and prevent [p 138] the yoke from shifting during fire.

Nuts installed on pins are secured by cotter pins (not shown in fig. 24).

2. GUN AMMUNITION FEED AND LINK REMOVAL SYSTEM

The gun feed system is a closed system (fig. 25). The cartridge belt is located in a special feed track which is located between the fuselage skin and the fuel tank container.

When loading the gun, the first link emerging from the receiver housing is connected by means of a cartridge belt connector with the last link of the belt, and during firing, the cartridge belt, while being fed into the gun, pulls the links behind it.

Thus, the links take up the space in the track vacated by the cartridges.

After expending the basic load, the links are removed from the feed

track before a new load is installed.

The feed track consists of four parts: guide profiles with arresting plates, feed chute, upper and lower link guides, and servicing chute.

In case of damage, any part of the guide profiles can be removed. [p 140]

For this purpose, the feed track has four technological joints. All joints are connected by means of steel inserts. These joints are located in the following places:

The first joint is located under the lower panel of the fuel tank container between frames 13 and 14. Access to the joint is effected through the hatch in the outer skin of the fuselage and a hatch in the servicing tray under the lid of the fuselage hatch.

The second and third joints are located in the upper part of the fuselage between frames 13 and 14, on the right side. Access to them is effected through the fuel tank hatch.

The fourth joint is located at the point where the cartridge belt guide is connected with the feed chute.

The cartridge belt guide is a ring type and is located between frames 13 and 14.

The guide profiles of the cartridge belt are made of stainless sheet steel and consist of two U-shaped profiles welded to the belt. The belt with the profiles is riveted to the fuel tank container jacket.

Guide plates (runners) are welded onto the upper part of the profiles to prevent disconnection of the links during charging (fig. 25, sec A-A).

The feed chute serves to feed the cartridge belt to the gun receiver. It has a removable lid which serves as an access while installing the belt. [p 141]

The upper and lower link guides (fig. 25, part "V") serve to prevent links from becoming disconnected upon emerging from the gun and to guide them when they enter the cartridge belt guide. They are stainless steel trays forming a short sleeve with the same cross-section as the link.

The upper link guide is attached to the track by a rod and by marine bolts to tie rods which are fastened to the fuselage bracket. The lower guide is attached by two spring stem locks.

The lower link guide is attached by its lugs to the locks of the upper link guide.

When the set screw of the lock is pulled by its outer ring, the lower guide unlocks. Its lugs disengage from the lock's stems and it can be removed.

Cartridge belt servicing

The cartridge belt is serviced through hatches by means of a servicing device and a winch.

The procedure for servicing the cartridge belt is as follows: the winch's runner (fig. 26) is slid into the guide on the gun's jacket opposite the case ejector aperture and is secured against shifting by a pin.

Structurally, the winch consists of a housing with a drum on which cable (3) is wound. The cable is wound by means of crank (9) which is connected to the drum by a gear and pinion. A hook, which hooks onto the car- [p 142]

tridge belt, is located at the end of the cable.

First, prior to servicing the belt, the winch cable has to be run over the guides. This is done by using a servicing device which consists of wire with Bowden coating which, at one end, has a plate with a hole in it for connecting the device with the winch cable hook, and at the other end -- a handle.

The servicing device is introduced into the feed track from the side of the servicing chute and is pushed through to the gun receiver.

The winch cable is hooked onto the plate of the servicing device and is pulled by hand, using the handle of the device, to the servicing chute over the guides (counter-clockwise in relation to the flight direction.)

After the winch cable is positioned over the guides, it is disconnected from the servicing device and hooked onto the first empty link of the cartridge belt. The cartridge belt is then pulled by means of the winch over the feed track guides until it reaches the gun receiver.

The cartridge belt ends are connected by a permanent steel strip with [p 144] hook (7) on one end, and eyelet (5) on the other. The hook and the eyelet both have spring catches (4).

The same winch used for servicing the cartridge belt is also used for binding together the ends of the cartridge belt, with the exception that the cable is removed from pulley and swing arm (4) (fig. 26) of the winch is turned down.

When the cartridge belt is being serviced in the feed chute, the connector is fastened by means of its hook to the last link of the belt.

The ends of the cartridge belt are bound together as follows:
after the cartridge belt has been serviced, the winch cable is disconnected from it, removed from the swing arm pulley, as described above, and the cable hook is hooked onto the edge of the rectangular hole made in the belt connector near its hook.

The cartridge belt is tightened by the winch cable until it is possible to fasten the connector's eyelet with the first link in the gun receiver, after which the belt is connected.

The winch cable is released by turning the crank counter-clockwise and is then unhooked from the cartridge belt. The winch is then removed.

In practice fire, a connecting belt is used.

[p 146]

It consists of several sections of steel strips which are connected by hinges.

When ten cartridges are loaded, the entire belt is used. When fifteen cartridges are loaded, the first section of the belt (# 1) is removed.

When 20 cartridges are loaded, section # 2 is removed, and with 30 cartridges, sections # 2 and 3 are removed.

The connecting belt is installed in the same manner as the combat belt.

3. SHELL EJECTION SYSTEM

Spent shells are discharged from the gun shell ejector aperture into the atmosphere through a slot in the speed brake.

4. DEVICES PROVIDING AIRCRAFT SAFETY
AND STABILITY DURING GUN FIRE

Gas deflector

A gas deflector is installed in order to provide stability to the aircraft when firing the gun in the air and to eliminate the effect of recoil action on the accuracy of fire. It is attached to the channel of the nose part of the fuselage in such a way that the thickened muzzle of the gun barrel fits into the deflector housing.

The deflector consists of: a hose (1) (fig. 28), the deflector [p 147] proper (2), and housing (5) which are connected to each other by threaded joints.

The deflector proper is located in front of the barrel muzzle and is a steel cylindrical body with an opening in its lower part through which gas escapes. The cylinder's bore is partitioned by a baffle plate (3) welded to the inside of the cylinder on an angle of 45° and has an opening for the passage of projectiles.

Powder gases, striking the slanted baffle, create the necessary impulse to compensate for the rotation of the axis of the aircraft caused by the recoil action.

The housing is placed over the gun barrel muzzle and is screwed to the deflector. The housing serves to prevent gases from escaping into the gun compartment.

Two eccentric ring bushings (6 and 7) installed in the housing provide for aiming and adjustment of the gun during adjustment firing.

The surface of the inside ring bushing (7) is spherical, which reduces the friction area when the barrel slides back and forth during firing.

The deflector is attached to the fuselage channel by five bolts.

Gas exhaust, fairings, and hatch

[p 149]

/ covers for the gunnery system

The gas exhaust serves to eliminate part of the powder gas coming from the gun counter-recoil mechanism during fire.

The gas exhaust is a round steel housing made of two stamped steel halves welded together, and having a cylindrical sleeve through which part of the powder gases are eliminated into the atmosphere.

The housing is attached to the aircraft frame by a lug welded to it.

The gas exhaust is placed over the gun counter-recoil mechanism and is attached to the body of the aircraft by bolts screwed into anchor nuts in such a way that the housing compartment surrounds the rectangular holes of the counter-recoil mechanism, and the cylindrical sleeve fits into the round opening in the air brake (when the latter is in retracted position).

Each time the gun is dismounted, the gas exhaust must be detached from the aircraft body and removed together with the gun and then reinstalled together with the gun.

The barrel fairing and the gun compartment hatch covers are equipped with louvers (fig. 29). Through these, the airflow surrounding the aircraft sucks out powder gas which permeates into the gun compartment through

gaps between the gas exhaust and the gas counter-recoil mechanism of the gun, as well as through gaps between the gun barrel muzzle and the bushing [p 151] of the gas deflector housing.

The same type of louvers are found in the hatch covers of the feed track, which is also permeated by powder gases.

5. RELOADING SYSTEM

Reloading of the gun is done by means of compressed air, while the reloading control system is electrical (fig. 30).

The reloading system consists of a pressure tank (14) with a capacity of 1.8 liters, EK-48 electropneumatic valve (16), air valve (18), installed in the front gun mount assembly pipe lines, and electrical wiring.

The tank and the electropneumatic valve are installed near the rear gun mount assembly between frames 14 and 15.

Compressed air is fed to the tank from the aircraft's air system through reducer RV-50M and check valve (13) installed near the tank.

Reloading control and process of reloading

The reloading control system (fig. 30) includes reloading button (2) installed on the left console of the instrument panel, gun ready signal relay (3), electropneumatic valve EK-48 (16), and gun ready signal light (4).

Reloading is carried out with AZS [circuit breaker] "Pushka" ("Gun") [p 152] turned on. Pressing the button marked "Perezaryadka" ("Reloading") actuates the coil of the EK-48 electropneumatic valve which operates and lets com-

pressed air into the reloading air valve (18), which serves as a connector between the air system and the cylinder of the gun reloading mechanism.

Air pressure causes the valve to emerge from the housing and its rubber ring is pressed against the cover of the gun reloading cylinder; at the same time, the valve's ball blocks the valve's central opening. Compressed air enters the gun reloading mechanism cylinder through lateral flutes (see fig. 22) and creates pressure against the receiver piston.

Reloading of the gun takes place when the bolt moves back over the sear, the bolt pick-up (in the gun electric release (17)) closes the gun ready signal relay circuit; the relay operates and closes the circuit of the gun firing ready signal light (4).

When the electropneumatic valve is turned off, the barrel counter-recoils together with the receiver piston (see technical description of the gun NR-30).

Compressed air in front of the receiver piston leaves the reloading [p 154] cylinder, enters the reloading valve, and by its pressure, interferes with the valve ball. The ball is pushed into the seat and returns the valve to its initial position. When the barrel reaches its maximum forward position, the barrel [bolt] pick-up (in the gun's electric release 17) closes the gun firing ready signal light (4) circuit, and the light goes on.

6. FIRE CONTROL SYSTEM

Firing of the gun is done electrically by remote control and is accomplished by pressing the firing button located on the aircraft control stick.

Included in the fire control system are (fig. 30):

- AZS-5 marked "NR, SS, RS, FKP" ("Gun, Missiles, Rockets, Gun Camera") (12);
- AZS-10 marked "Pushka" ("Gun");
- fire control relay (9);
- range-only radar operating mode selector switch marked "RS, Pushka-SS" ("Rockets, Gun-Missiles") (15);
- circuit switching relay for "RS, Pushka-SS" (7);
- sight selector switch panel (10);
- gun electric release (17);
- fire control button (11);

The following must be switched on prior to firing:

[p 155]

- circuit breakers actuating the sight and range-only radar circuits;
- circuit breakers "NR, SS, RS, FKP" and "Pushka".

In order to interconnect the sight with the range-only radar, the range-only radar mode switch "RS, Pushka-SS" must be placed in the "RS, Pushka" position.

To put the sight in the appropriate armament operating mode, the following switches must be activated:

- selector switch "S-B" to position "S";
- selector switch "NR-30 - RS" to position "NR-30".

Following this, the gun is reloaded. Firing may begin after the gun fire ready signal light goes on.

To open fire, firing button (11) must be pressed. This actuates

fire control relay (9) which operates and actuates the gun electric release. The gun keeps firing automatically while the firing button stays pressed. In order to stop fire, the button must be released. This will release the fire control relay.

If, when conducting fire, AZS "FKP" (gun camera circuit breaker) is switched on, the fire control relay, as the firing starts, will simultaneously actuate gun camera SSh-45-1-100-OS.

Fig. 22. Front gun mount assembly

1-air line nipple; 2-valve housing; 3-check valve; 4-hinged part of yoke; 5-upper part of yoke; 6-attachment bolt; 7-tie bolt with nut; 8-attachment collar; 9-collar-g50X1-HUM'ew; 10-collar-yoke set screw.

50X1-HUM

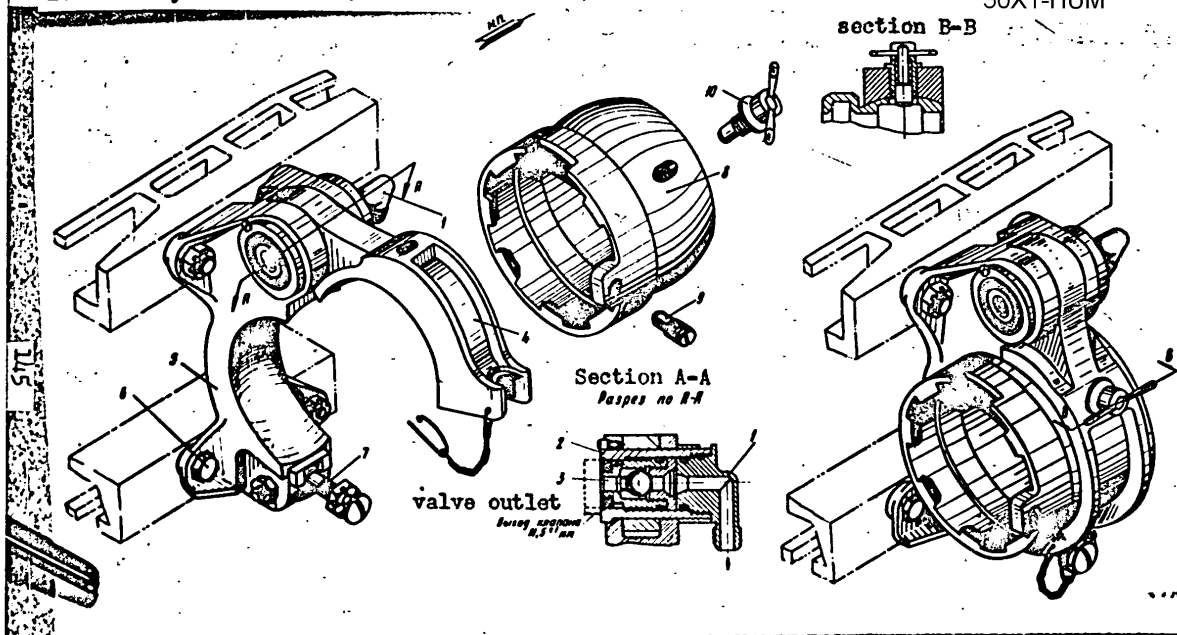
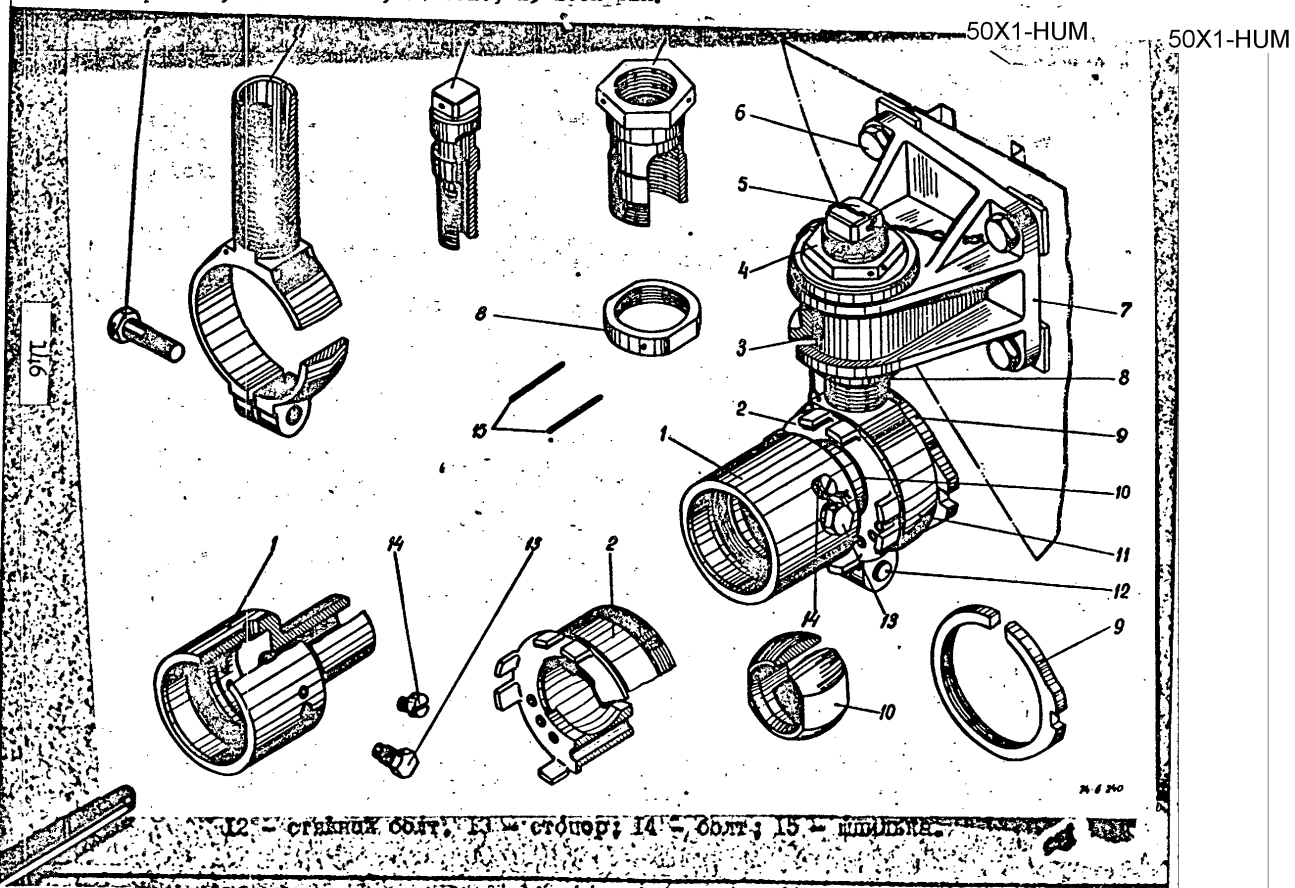


Fig. 22. Front gun mount assembly

1 - штуцер для воздушной линии; 2 - корпус клапана; 3 - обратный клапан; 4 - откидная часть хомута; 5 - верхняя часть хомута; 6 - болты крепления; 7 - стяжной болт с гайкой; 8 - кольцо крепления; 9 - стопор крепления кольца к пушке; 10 - стопор крепления кольца к хомуту.

Fig. 23. Rear gun mount assembly
1-extension shaft; 2-adjustment collar; 3-bushing; 4-adjustment bushing; 5-taper bolt; 6-bracket attachment bolts; 7-bracket; 8-lock nut; 9-nut; 10-ball bearing; 11-pintle; 12-clamp bolt; 13-lock nut; 14-bolt; 15-lock pin.



S-E-C-R-E-T

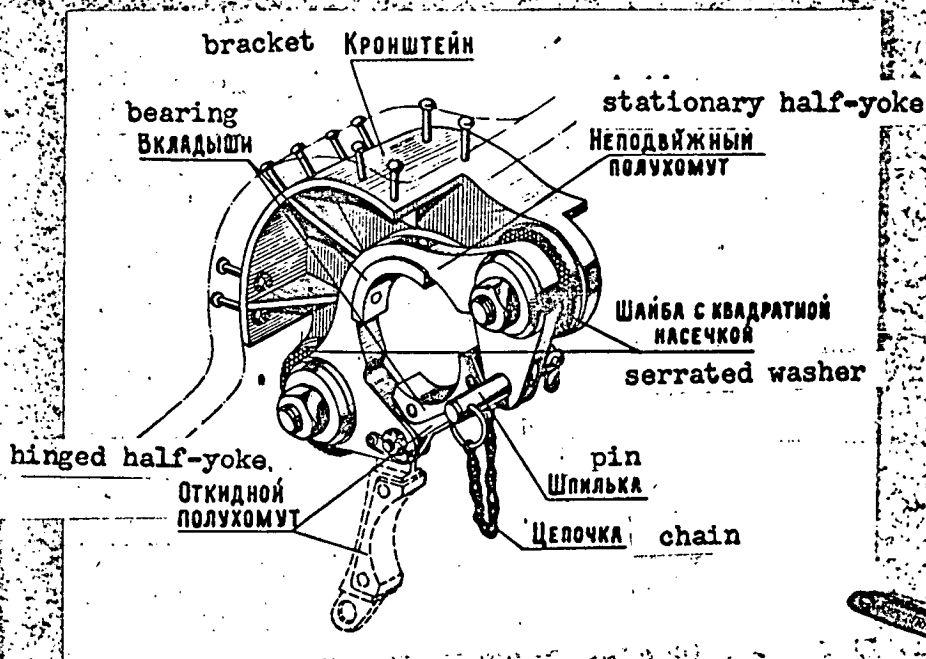


Fig. 24. Supplementary gun barrel mount assembly

ФИГ. 24 Узел дополнительного крепления
отвода душки.

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S-E-C-R-E-T

50X1-HUM

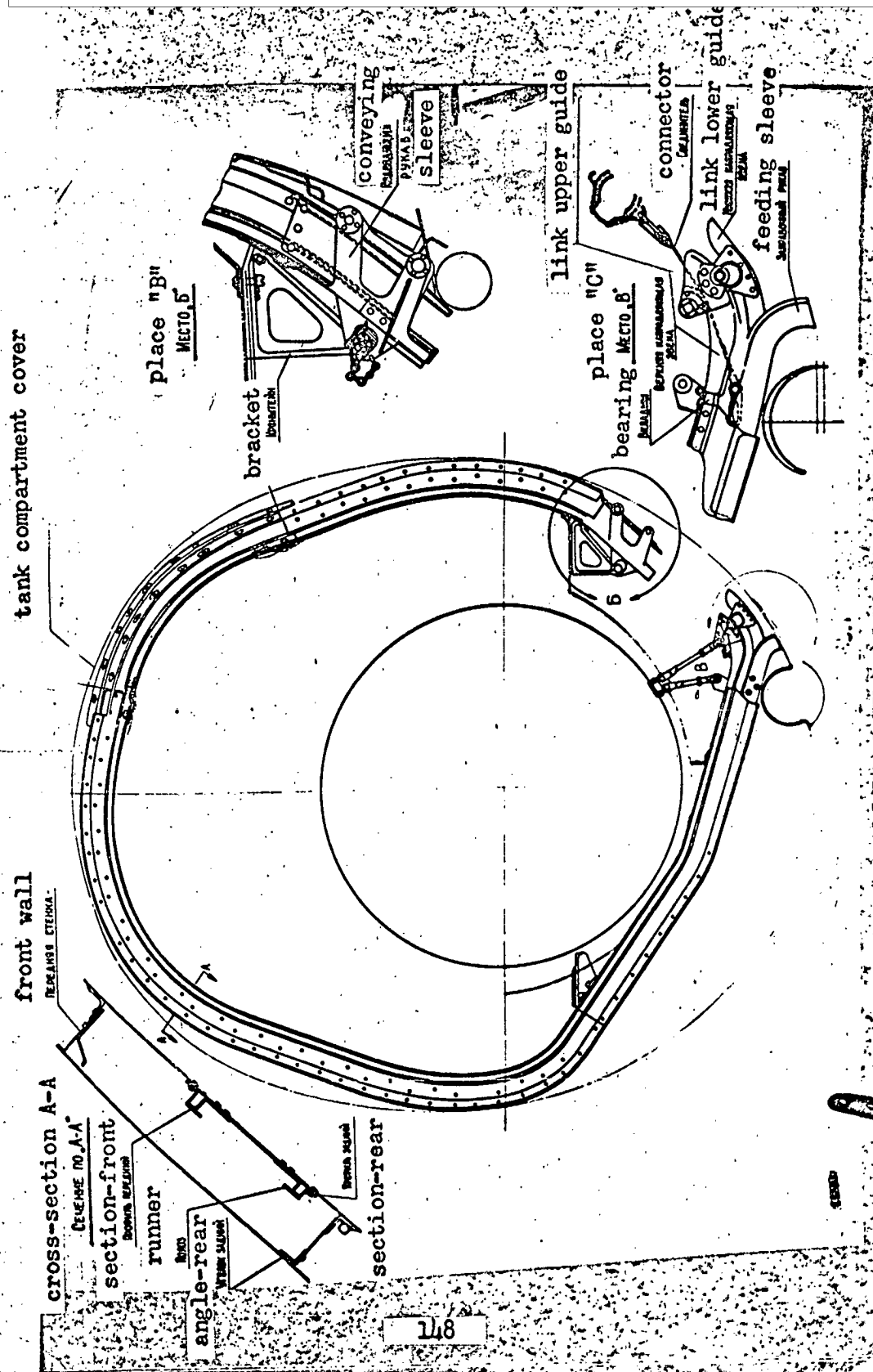


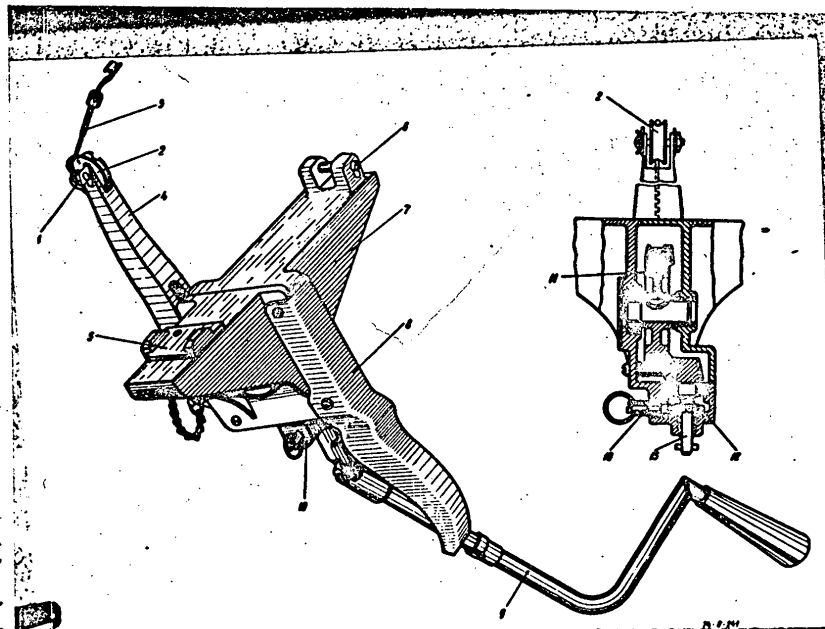
Fig. 25. Gun feeding track

S-E-C-R-E-T

50X1-HUM

50X1-HUM
50X1-HUM

Fig. 26. Winch for servicing cartridge belt.
1-actuator; 2-guide pulley; 3-cable; 4-guiding arm; 5-guide;
6-pin; 7-housing; 8-bracket; 9-handle; 10-actuator; 11-drum
gear; 12-ratchet; 13-pinion gear.



Фиг. 26. Лебедка для заправки патронной ленты.
1 - ограничитель; 2 - направляющий ролик; 3 - трос; 4 - направляющая;
5 - направляющая; 6 - шпилька; 7 - корпус; 8 - проушина; 9 - рукоятка
с шариком; 10 - стопор; 11 - шестерня-барaban; 12 - храповик; 13 - веду-
щая шестерня.

S-E-C-R-E-T

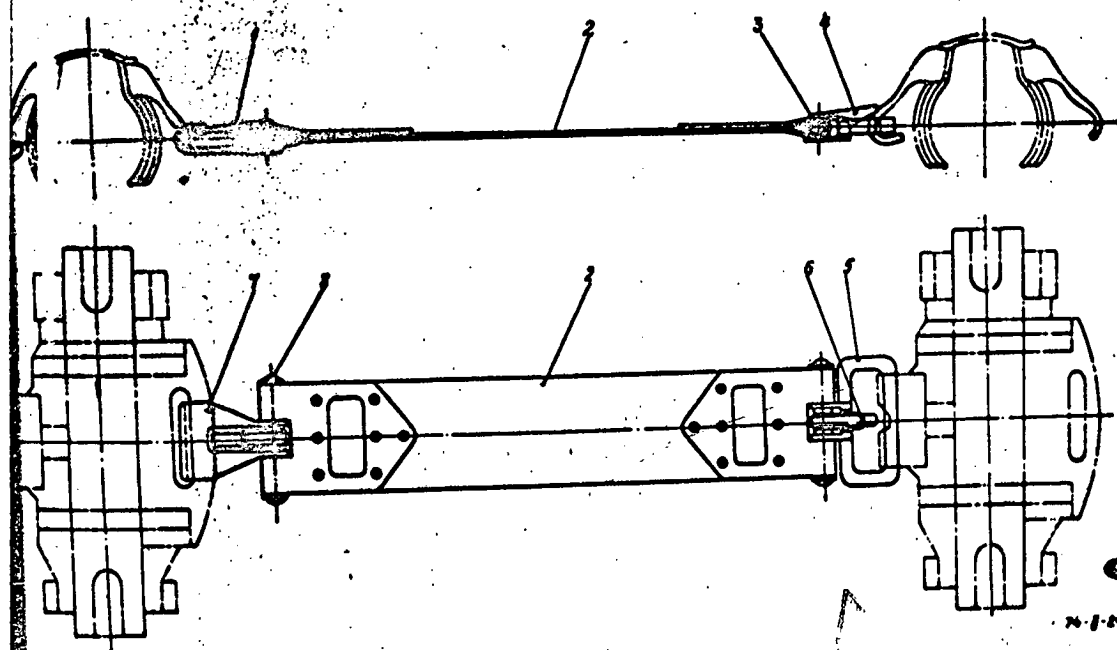


Fig. 27. Cartridge belt connector

1-clasp spring; 2-strip; 3-rod; 4-spring catch;
5-eyelet; 6-clasp spring; 7-hook.

Фиг. 27. Соединитель патронной ленты

1 - пружина заделки; 2 - лента; 3 - валик;
4 - заделка; 5 - петля; 6 - пружина заделки;
7 - крючок.

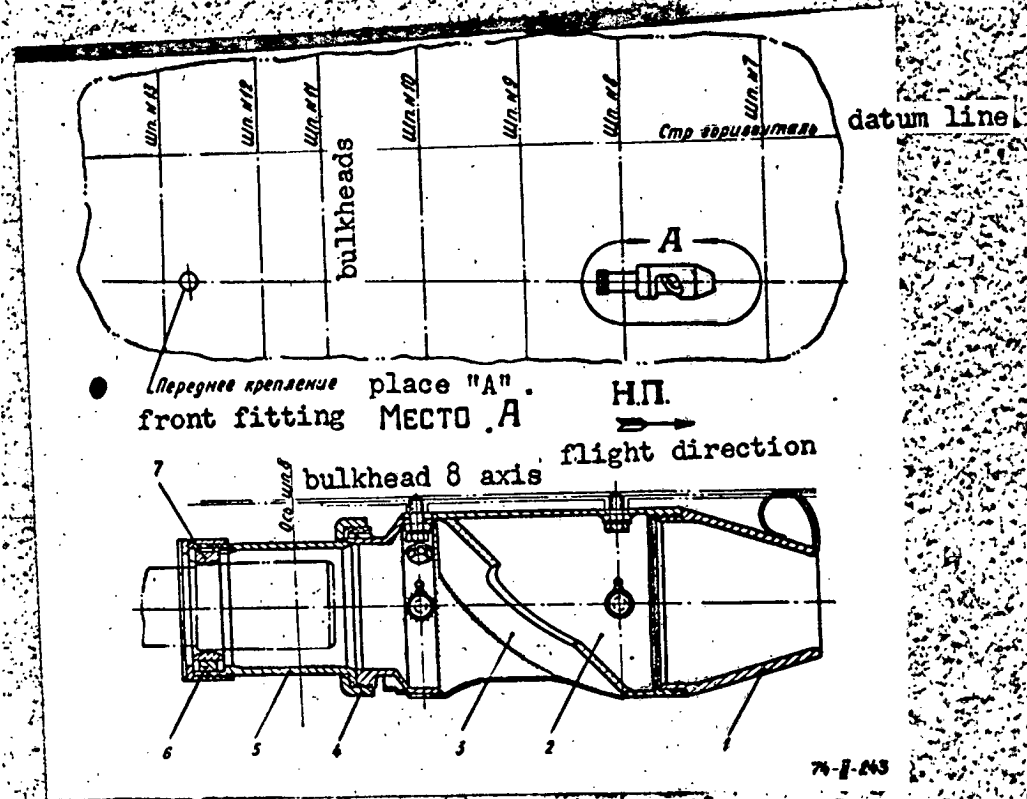


Fig. 28. Gas deflector

1-hose; 2-deflector; 3-baffle plate; 4-connecting nut;
5-housing; 6-ring bushing; 7-spherical bushing.

Фиг. 28. Газовый компенсатор

1 - носок; 2 - компенсатор; 3 - отражательная
пластина; 4 - соединительная гайка; 5 - стакан;
6 - кольцевая втулка; 7 - сферическая втулка.

50X1-HUM

50X1-HUM

1-inspection hatch for ring guide and cartridge belt; 2-gas deflector;
3-gun barrel fairing; 4-gas escape aperture in air brake; 5-right air
brake; 6-cartridge belt access hatch; 7-case ejection chute opening;
8-access hole for rear gun mount assembly, air tank, and reloading
system valve EK-18.

Fig. 29. Gun installation fairings and hatch covers

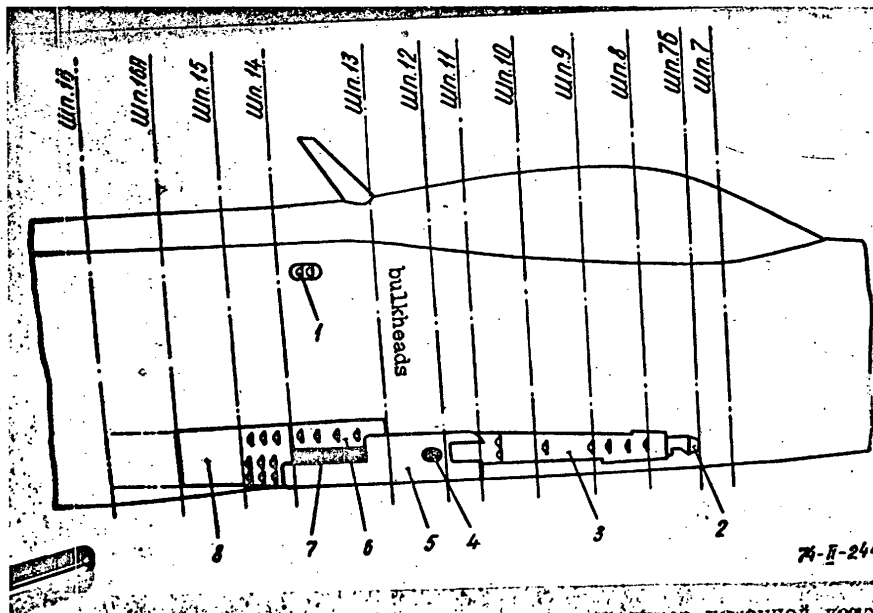


Fig. 29. Обтекатели и крышки люков пушечной установки.

1 - лючок для просмотра кольцевой направляющей и патронной ленты; 2 - газовый компенсатор; 3 - обтекатель ствола пушки; 4 - газоотводное отверстие в тормозном щитке; 5 - правый тормозной щиток; 6 - люк подхода к патронной ленте; 7 - газоотводное отверстие; 8 - люк подхода к главному узлу крепления пушки, воздушному баллону и клапану ЭК-18 системы перезарядки.

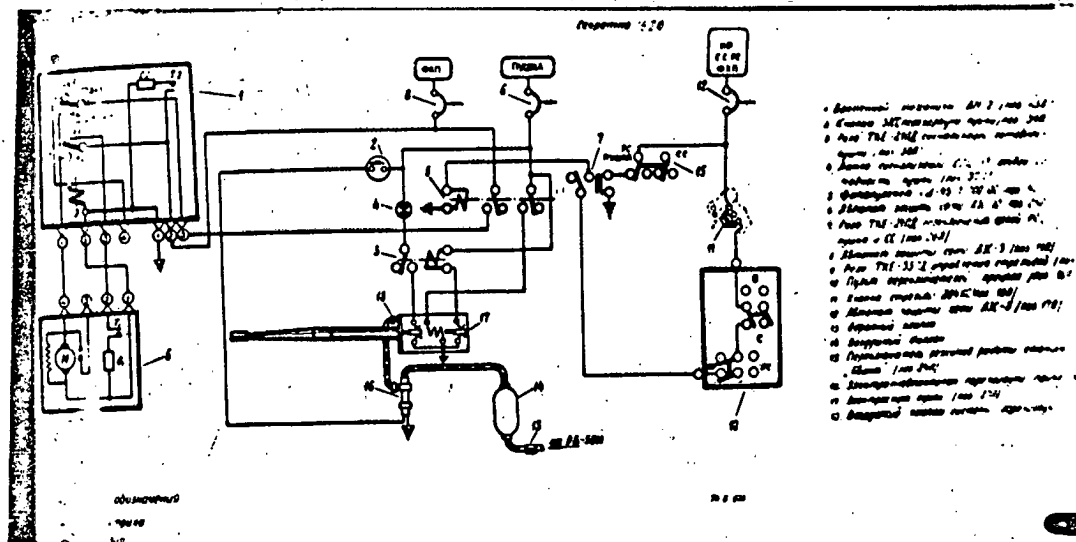


Fig. 30. Gun firing and reload control schematic diagram

1-time mechanism VM-2 (pos. 43P); 2-reload button (pos. 39P); 3-gun ready signal relay TKYe-21PD; 4-gun ready signal light (pos. 37P); 5-gun camera SSh-45-1-100-OS (pos. 42P); 6-AZS-10 - firing and reloading power supply circuit breaker (pos. 25P); 7-K-13 launching and gun and rocket firing circuits relay TKYe-21PD (pos. 26); 8-AZS-5 - gun camera circuit breaker (pos. 19P); 9-fire control relay TKYe-21PD (pos. 28P); 10-sight selector switch panel (pos. 16P); 11-fire control button (pos. 18P); 12-general circuit breaker AZS-5 for armament control circuits; 13-non-return valve; 14-air tank; 15-range-only radar operating mode switch (pos. 24P); 16-gun reloading electro pneumatic valve (pos. 40P); 17-gun electrical trigger (pos. 27P); 18-reloading system air valve (in gun mount assembly).

CHAPTER VI

ASP-5ND SIGHT SYSTEM WITH ANGLE-OF-ATTACK AND
YAW SENSOR DUAS-8M. AIRCRAFT INFRARED VIEWER
SIV-52. GUN CAMERA SSh-45-1-100-OS

The aircraft has an automatic aerial firing sight ASP-5ND with angle-of-attack and yaw sensor DUAS-8M which ensures operation of the sight in aimed launching unguided rockets, and aircraft infrared viewer SIV-52, interlocked with the sight for sighting under night flying conditions. Viewer SIV-52 may be removed from the aircraft (from the sight) and gun camera SSh-45-1-100-OS may be installed in its place for photographic recording of the sight's field of vision.

The sight and aiming devices installed on the aircraft include:

- set of sight units;
- bracket for attaching sight head and adjustment of its position during fire adjustment;
- components for attaching remainder sight units;
- electrical cable connecting the sight units with the electrical circuit;
- DUAS-8M angle-of-attack and yaw sensor equipment;
- viewer SIV-52 equipments;
- electrical power supply system for sight and infrared viewer, DUAS heating, and sight control.

[p 157]

Gun camera SSh-45-1-100-OS and its electrical control system are not connected with the sight installation.

1. SIGHT ASP-5ND WITH DUAS-8M SENSOR

A. Function. General information.

Sight ASP-5ND with angle-of-attack and yaw sensor DUAS-8M used on the MIG-21F-13 aircraft is intended for aiming when firing the fixed mount gun, launching unguided rockets, or launching K-13 homing missiles.

The sight is a complex optical-electromechanical device and is interlocked electrically with the range-only radar SRD-5MK, which automatically provides target range, and optically -- with the aircraft infrared viewer SIV-52, intended for aiming when firing at night. The sight can be interlocked with other range -- only radars and radar sets.

The sight is designed for a number of different ballistics, but makes angular corrections for only one of them at a time (i.e., for one type of weapon).

Sight ASP-5ND solves the problem of sighting during aerial firing [p 158] by automatically and continuously computing the value of the angle between the longitudinal axis of the firing aircraft and a moving sight line (total angle correction), taking into account the changing parameters of fire, and alters the sight line by this angle in the sight's field of vision, ensuring passing of the missile trajectory through the target.

The maximum total angular correction produced by the sight is 13°.

When the gunnery system is fired, the sight continuously and automatically produces angles of advance and sight, and when launching unguided rockets -- angles of advance, sight, and lag. The angle of lag for unguided rockets is determined taking into account the angles-of-attack and yaw, i.e., by horizontal and vertical components, which increases the accuracy of aimed launching of rockets. A special angle-of-attack and yaw sensor DUAS-8M is installed in the aircraft for supplying these data to the sight. The DUAS wind vanes are located in the airstream during flight, i.e., in line with the direction of the aircraft's actual speed vector, and the angular rotation of the vanes in relation to the aircraft's axis is fed to the sight in the form of voltages, taken from the brushes of the DUAS potentiometers, proportional to these angles. [p 159]

The ASP-5ND sight makes angle corrections for the following conditions:

target range	- 200 to 2000 m
flight altitude	- 500 to 25000 m
target speed	- 500 to 2250 km/hr
actual speed	- 500 to 2500 km/hr
surrounding air temperature	- -60°C to +50°C.

Angle-of-attack is also fed into sight ASP-5ND from the altitude indicator as a function of altitude (H), average speed at the given altitude ($V_{avg.}$), and average value of overload at the given altitude (O_H).

Angles-of-attack fed from DUAS are taken into account by the sight within a range of 0° to $+10^{\circ}$, and angles-of-yaw -- within a range of $\pm 4^{\circ} 30'$.

Derivation of total angular corrections of advance, sight, and lag is carried out with respect to the value of computed time calculated as a function of range and altitude within limits of 0.25 to 4 sec., and also with respect to the angles-of-attack and yaw.

Range may be fed to the sight from the range-only radar or manually from an externally based optical range finder by means of a handle on the throttle control lever quadrant.

In the sight, a floating illuminated range ring of variable diameter is formed with a point in the center (sight grid), which changes from $1^{\circ} 15'$ to 8° . When the arrester handle is in "Stationary" position, a grid with a range ring of $1^{\circ} 15'$ to 8° is formed in the sight by means of lever "Base-Ring" (angular value of the ring radius changes from 11 to 70 thousandths). The target size (base size) is established at 7 to 70 m.

When the range-only radar locks on the target, the sight is automatically switched to range-only radar operation.

When the range-only radar is turned on but is not locked on the target, the sight is automatically switched to optical range finder operation.

In case of range-only radar failure or when firing at ground and aerial targets at low altitudes, a manual change-over to the externally based optical range finder is provided for on the sight.

In cases of failure of individual mechanisms, the sight may be used as a collimating viewer; in this case, alteration of the range ring diameter is done by means of lever "Base-Ring."

D-c potentiometer bridge circuits are used as electrical computers in the sight, with electronic relays acting as sensing elements [p 161] and reversible magnetic clutches -- as the working elements.

The sight operating mode controlled by selector switches;

- Switching the sight to connect it with a range-only radar of one type or another is done on the ground by means of a special switch in the sight control box.
- To ensure the input of angle-of-attack data from the altitude indicator as functions of altitude, average speed at a given altitude, and average overload value with differences in functions for different types of aircraft taken into account, pairs of resistors are installed in the sight control box. Turning on the required pair of resistors is accomplished by placing selector switch Pkr-3 in the position suitable for the particular type of aircraft on which the sight is installed. On the MiG-21F-13 aircraft, switch Pkr-3 in the sight control box must always be turned to position "21".
- Switching the sight for use with the particular type of unguided rocket ballistics (any type) is accomplished by the ground installation of the appropriate interchangeable ballistics unit in the sight control box.

The interchangeable unit represents a bracket on which the resistors are installed. The bracket with the resistors is mounted on two RP type blocks in a closed housing. The housing of each ballistic unit supplied with each sight has markings on it which correspond to the particular type of rocket used. [p 162]

When launching pads UB-16-57U are used, units installed in the sight control box must be those which conform to the ballistics of rockets 8-5M or S-5K.

Change of sight operating condition to that of producing total angular corrections for gunnery or unguided rocket ballistics (switching mode of operation) is accomplished by sight operating mode switches installed on the sight head bracket with light filter in the following manner:

- selector switch "S-B" must be in position "S" for all sight operation modes;
- fire selector switch "NR-30 - Rockets" must be in position "NR-30" for operation with the gun or with the K-13 system, or in position "Rockets" for aimed launching of rockets;
- selector switch for sight operation with the altitude indicator or with angles-of-attack-and yaw sensor "N-DUAS" must be turned to position "DUAS" for aimed rocket launching, and only in case of the DUAS-VM unit being out of order should it be placed in position N. In the latter case, total angular correction will be made in the sight using only the angles of attack fed by the altitude indicator. [p 163]

- Manual switching of sight operation from range-only radar to operation with externally based range finder is done by placing selector switch "Radar-Optics" in position "Optics".

The sight has a red signal light with the sign "withdraw" used in gun firing and rocket launching. The light goes on when the target range reaches 600⁺⁵⁰-20 meters.

On the ground, visual monitoring of range, altitude, and indicated time T may be simulated by connecting to the sight a range-only radar simulator and a special vacuum apparatus and using appropriate computer and altitude indicator scales.

In flight, the following are subject to visual monitoring:

- The moment of target lock-on by the range-only radar by the burning of green signal light "Lock-On";
- target range -- by the range indicator dial installed on the sight head bracket (monitored range is 2000 to 200 m);
- the moment of withdrawal from attack -- by the burning of red signal light "Withdraw."

Photographic recording of the sight's field of vision is accomplished by means of gun camera SSh-45-1-100-OS.

[p 164]

In the K-13 system, when K-13 homing missiles are launched, sight ASP-5ND is used as an ordinary collimating sight; in this case the gyroscope arrester handle of the sight head must be placed in position "Stationary."

The range-only radar in this case is operating in mode "B" and does not feed range to the sight (the range-only radar operating mode switch is placed in position "SS" ("Missiles")). The sight operating mode switches are placed in the following positions:

"B-S" - in position "S";

"NR-30-- Rockets" - in position "NR-30";

Position of selector switch "N - DUAS" is immaterial.

In this operating mode the following are subject to visual control:

- the moment of target lock-on by the range-only radar, signalled by burning of signal light "Lock-On" on the sight head;
- target range shown by range indicator UD-1 (scale 8000 to 0 m);
- permissible missile launching range signalled by the burning of signal light "Permissible Range";
- the moment of withdrawal from attack signalled by the burning of signal light "Withdraw from Attack" of the missile launching range finding system. [p 165]

In gun firing or aimed rocket launching the sight operates automatically. The arrester handle must be placed in position "Gyro". The range-only radar in this case is operating in mode "A", feeding target range data to the sight (the range-only mode switch must be placed in position "Rockets, Gun").

The sight operating mode selector switches are placed respectively in positions:

"S", "NR-30" - for firing guns;

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S-E-C-R-E-T

50X1-HUM

"S", "Rockets", "DUAS" - for aimed rocket launching with sight ASP-5ND interlocked with the angle-of-attack and yaw sensor;
 "S", "Rockets", "N" - for aimed rocket launching with angle-of-attack taken from the altitude indicator (this position is recommended only when DUAS has failed)

For these operating conditions the following are subject to visual monitoring:

- the moment of target lock-on by the range-only radar, signalled, by the burning of signal light "Lock-On" on the sight head;
- target range read on the range indicator installed on the sight head bracket (scale 2000 to 200m);
- the moment of withdrawal from attack, signalled by the burning of signal light "Withdraw" on the sight head. [p 166]

Sight combat readiness time:

At plus 20° C temperature	3 min
At minus 40°C "	10 min
At minus 60°C "	14 min

B. Function of Sight ASP-5ND Units and Their Location on the

Aircraft

The ASP-5ND sight set includes the following units: sight head with attachment OES-2 (unit #1), computer (unit #2), zero gyroscope amplifier (unit #4), control box (unit #5), altitude indicator (unit #6), electronic relay (unit #8), voltage stabilizer (unit #9), and the sight head bracket with light filter, selector switches, and range indicator.

The sight head of the collimator type with 95 mm lens and a focal distance of 200 mm is intended for creating a grid image within the sight's field of vision and deflection of this image through the necessary angles, as well as for transmission of the grid image through attachment OES-2 to sight SIV-52. The grid is a continuous ring of varying diameter with a dot in the center.

The light-separating surface of the reflector is covered with a three layer titanium coating which provides for brightness of the ring image of not less than 30 stilb, and brightness of the center dot of not less than 36 stilb. [p 167]

The lens surface is coated with a heating layer to prevent moisture condensation of the lens.

The sight head is installed in the aircraft cockpit above the instrument board and in the center, on a bracket made of cast magnesium, and is attached directly to the bracket with the sight light filter. The position of the head is adjusted in such a way that the central viewing beam lies in the plane of symmetry of the aircraft and is inclined downward at an angle of $-1^{\circ}30'$ in relation to the horizontal datum line of the fuselage (see fig. 4). The distance of the sight head collimator's optical axis from the plane passing through the center of the forward gun mount assembly, perpendicular to the longitudinal axis of the aircraft, is 1550 mm (in the direction of flight); the distance of the reflection point of collimator's central beam on the sight head reflector to the horizontal datum line of the fuselage is 816 mm above the latter. Due to refraction by the front

bulletproof glass, the central viewing beam comes out of the glass at a point located higher than the horizontal datum line of the fuselage by 844 mm, i.e. 28 mm higher than the first point. This is taken into account when setting up targets for adjustment firing.

On the sight head are located:

- signal light (green) "Lock-On" which lights up when the target is locked-on by the range-only radar (see fig. 31);
- signal light (red) "withdraw" which goes on when the target range is reduced to 600 ⁺⁵⁰ -20 m. It signals the necessity of withdrawing from attack when gun and rockets are used. [p 168]
- handle "Gyro-Station." for caging and uncaging the sight head gyro;
- handle "Base-Ring" used to establish target size and to control the size of the range finder grid ring;

Bracket with light filter of the sight is used for mounting the sight head and adjustment of its position during adjustment firing. The front yoke and two rear clamps of the bracket are attached by bolts to an aircraft bracket, the forward lug of which has a spherical bearing. The rear bolt holes in the aircraft bracket are elongated which allows for adjustment of the sight head in a horizontal plane. Adjustment in a vertical plane is done by changing the position of the bolt nuts up or down.

On the side of the bracket with light filter are installed:

- range indicator giving the pilot the distance to the target, supplied by the range-only radar, or manually by the range lever on the gas throttle quadrant (0-2000m)

[p 169]

- three sight operating mode switches:

"NR-30-Rockets" for firing

/"N - DUAS" - operating from altitude indicator or from the angle-of-attack and yaw sensor DUAS;

- "S - B" - must be placed in position "S" for all operating modes.

On the right side of the bracket with light filter are installed:

- neon signal light "RD-High Voltage", indicating presence of high voltage when switching on the range-only radar;

- sight operating mode switch "Radar-Optics", allowing manual switching of sight to conditions of manual range introduction and switching on of range-only radar.

On the bracket, on the box with the selector switches and range indicator of the sight, are installed aircraft brackets with:

- equipment for determining K-13 missile launching range, signal lights "Permissible Range", "Overload Signal", and "Withdraw from Attack", and range indicator UD-1 (see fig 13)
- target clearing button.

Almost all remaining units of the sight are located in the forward equipment hatch in the nose part of the fuselage.

The computer contains the basic potentiometer elements of the computing circuits of the sight. It is located in the forward equipment hatch on the left between frames 3 and 4.

[p 171]

The Zero Gyroscope is used for measuring the aircraft's own angular velocity, necessary for construction of angles of advance and angles of sight in firing the gun or in aimed rocket launching. It consists of three main components: gyroscope, variable inductor, and base with compensating system. The gyroscope is placed in a heat-resistant housing.

The zero gyroscope is installed in the forward equipment hatch between frames 2 and 2A, in the upper center part exactly in line with the aircraft axes.

Maximum allowed deviation of the gyroscope axes in relation to those of the aircraft when installing the former area:

Vertical axis	$\pm 45^\circ$
lateral axis	$\pm 30^\circ$
longitudinal axis	$\pm 30^\circ$

The zero gyroscope electronic amplifier is used to amplify compensating currents flowing through the coils of the zero gyroscope compensating system. The electronic amplifier consists of two identical, independently operating channels, each providing amplification of signals proportional to the horizontal and vertical components of the aircraft's angular velocity. [p 172]

The electronic amplifier is installed in the forward equipment hatch between frames 5 and 6, in the right upper part.

The control box serves as commutator for the electrical circuits of the sight unit and their control for different sight operating conditions. The control box consists of two units: a distributing

box and a relay box. The control box is installed in the forward equipment hatch in the left upper part between frames 5 and 6.

The altitude indicator provides stepless supply of the altitude function to the computing circuits of the sight. The inner area of the hermetically sealed chamber of the altitude indicator is connected by a pipe to the chamber of the Pitot-static head.

The altitude indicator is located in the forward equipment hatch in the upper center between frames 5 and 6 (between the zero gyroscope amplifier and the sight control box).

The electronic relay is intended for automatically setting up the range ring in the sight head and serves as a connecting link between the computer and the range ring mechanism of the sight head.

The electronic relay is located in the forward equipment hatch on the upper right, between frames 5 and 6 (next to the zero gyroscope amplifier).

The voltage stabilizer is intended for stabilizing the d-c network voltage fed to the sight, up to 22 v with an accuracy of ± 0.3 v. It supplies a stabilized voltage of 22 v to the computer circuits of the sight (circuits for advance and aiming, ballistic bridge circuits, and range ring circuits) [p 173]

The voltage stabilizer is located in the aircraft cockpit behind the instrument panel in the aircraft's plane of symmetry, between frames 6 and 7 above the horizontal datum line.

V. Electrical power supply circuits for sight
ASP-5ND, viewer SIV-52, sensor DUAS-8M and
sight control

The circuit diagram shown in fig 32 provides separate control of current supply for the sight, SIV-52 viewer, and heating of DUAS, as well as separate sight control: damping, control of the manual introduction of range from an externally based optical range finder, and switching of the internal sight circuits and aircraft circuits in accordance with the type of armament being employed.

Power to the sight and infrared viewer is blocked against high current by means of relays 13 (33E) and 14 (17E) and is supplied only when the aircraft's generator is in operation or when current is supplied from an airfield source.

An a-current of 115 v, 400 cps is supplied to the sight, infrared [p 174] viewer, and the k-13 system from centralized converter PO-500A with separate switching on through corresponding circuit breakers and relays.

Operation of Power Supply Circuit and Control of the ASP-5ND Sight

The sight maintains its accuracy in providing angular corrections when supplied by $27 \text{ v} \pm 10 \% \text{ d-c}$ and $115 \text{ v} \pm 5 \% \text{ a-c}$ with frequency of $400 \text{ cps} \pm 5 \%$

Power consumed by sight:

direct current under normal conditions 300 w

direct current at temperature of 40° C and below 400 w
 alternating current 120 va

The sight is fed +27 v from the aircraft network through noise filter F-14A, and 115v, 400 cps from converter PO-500A.

When the network is fed by the aircraft generator (or an air-field source of power is connected) relay (46S) (not shown in fig 32) operates and signals switching off of the generator and switching in of high-current relays. A voltage of +27 v is fed from terminal "5" of this relay to the coil of high-current 14 (17E). Contacts of relay 14 close and ready the sight direct and alternating current circuits for operation.

When AZS (circuit breaker) "Sight, Sight Warning" 3 (IP) is [p 175] switched on, +27 v passes through the AZS contacts, the closed contacts of high-current relay 14 (17 E), and noise filter 15 (4P) and passes:

- through terminal "1" of plug connector PG-2 to the collimator grid illuminating light (through its rheostat) and to the warming system of the sight, (gyroscope, semi-transparent mirror, lens of the sight head, and zero gyroscope);
- to AZS "Sight" 4 (2P).

When AZS "Sight" is switched on, the aircraft network voltage is fed to the remaining sight circuits:

- to damping button 5 (8P);

- to manual range feed potentiometer 6 (15P);
- to sight selector switch panel 7 (16P);
- to terminal "5" of plug connector PG-1;
- to the coil of relay 17 (4OR) of the sight a-c supply. Relay 17 operates and sends by its closed contacts a "minus" voltage for starting converter PO-500A, connected with the positive bus through type IP-50 mechanical fuse 1 (23R). The converter triggers and a voltage of 115 v, 400 cps flows from terminal "6" of the converter through type SP-5 safety fuse 11 (20R) and closed contacts of relay 17 to the sight control box 22 (5P) and through the latter to the sight circuits (zero gyroscope with amplifier, altitude indicator, bridge for range ring setup).

[p 176]

Damping button 5 (8P), installed on the aircraft control stick handle, prevents sight grid washout during sharp banking of the aircraft. Pressing the button sends an additional +27 v to the electromagnetic limiter which, as a result, reduces the angle of deflection of the gyroscope.

The brush of the manual range introduction potentiometer 6 (15P) (P_{12} in the sight circuit) is connected functionally with the handle in the throttle control quadrant.) When turned, the handle moves the brush. At the same time, an error signal appears in the form of a voltage difference between the brushes of potentiometer P_{12} and the receiving potentiometer P_{11} of the automatic range introduction bridge of the sight. The voltage difference is fed to the

automatic components (relay, reversible clutch), which move the P_{11} potentiometer brush to the position at which the difference becomes zero.

Mechanically linked with potentiometer P_{11} are potentiometers: P_4 of the ballistic bridge, P_{16} of the range ring, and P_{17} of the range indicator circuit, whose brushes also are moved proportionally to the range; at the same time, the size of the range ring changes. Accurate framing of the target by the range ring produces the correct calculation of range in the receiving potentiometer P_{11} . Accurate framing of the target by the range ring is achieved by turning the handle in the throttle control lever quadrant; as the result, present target range is fed into the sight.

Selector switches "NR-30-Rockets", "N-DUAS" on the sight head bracket panel 7 (16P) are placed in positions corresponding to the type of armament employed, while selector switch "S - B" is placed in position "S". At the same time, one of the ballistics switching relays is cut in. The contacts of this relay change the ballistics bridge resistor group and the aiming circuits, adjusting the circuit for the making angular corrections for the particular type of armament.

[p 179]

Operation of power supply circuit for warming DUAS-8M

A voltage of +27 v is fed to the heating elements of the DUAS-8M angle-of-attack and yaw sensors (29) (9T) through terminal "8" of plug connector R69 when AZS "Heater PVD, Clock" 31 (7T) is turned

on. The DUAS potentiometers are fed a voltage from the sight circuits.

Operation of power supply circuit for aircraft infrared viewer

SIV-52

Normal operation of the viewer is assured by feeding to its power unit 115 volts 400 cps a-c from converter PO-500A.

Maximum power consumption is 10 va.

When the network is supplied by the aircraft generator (or from an airfield power source) relay (46S) (not shown in fig. 32) triggers and signals generator switch-off and high-current apparatus switch-on. The terminal "5" of this relay, + 27 v is fed to the winding of high-current relay 13 (33E). Relay 13 contacts close and ready the viewer supply circuit for operation. [p 180]

When AZS "SIV" 2 (46P) is switched on, +27 v is fed through the AZS contacts and the closed contacts of high-current relay 13 (33E) to the winding of SIV-52 power supply relay 16 (48R). Relay 16 triggers and sends through its closed contacts a "minus" voltage for starting converter PO-500A. The converter starts, and from its terminal "6", 115 v, 400 cps passes through type SP-5 safety fuse 10 (47R) and closed contacts of relay 16 to terminal "1" of sight SIV-52 power unit 20 (44P).

The power unit converts the 115 v, 400 cps voltage to 18 kv direct current which is fed from the power unit to the SIV observing instrument (21).

2. ANGLE-OF-ATTACK AND YAW SENSOR DUAS-8M

The DUAS-8M sensor is a tube (Pitot-static head) in which are installed an air pressure receiver, which provides for operation of barometric instruments, and angle-of-attack and yaw sensors used to feed data to the sight on angles of attack and yaw of the aircraft.

The DUAS-8M sensor is installed on the forward end of a rod protruding forward in the direction of flight and has its PVD receiver facing the airflow. The sensor's electrical cable is placed inside the rod and is connected to the sight electrical system by means of a 9-pin plug connector (R69). Access to the connector is through the hatch of loop antenna ARK in the lower nose part of the fuselage. [p 181]

The sensor has four vanes for measuring of angles of attack and yaw installed in pairs on two mutually perpendicular axes. The front pair of vanes 6 (fig 33), located in the aircraft's plane of symmetry is intended for measuring yaw angles, while the rear pair, located in the horizontal plane is intended for measuring angles of attack of the aircraft. The rotation axes of the vanes are mechanically linked with brushes 3 and 10 of potentiometers 2 and 7 installed inside the DUAS tube.

The principle of operation of the sensor is based on the change in relative output resistance (voltage) with respect to the position of the vanes. Each specific position of the vane corresponds to a definite value of relative output resistance (voltage), representing the ratio $\frac{\text{output } R}{\text{total } R}$ in percent.

When the aircraft angle-of-attack or yaw changes, the sensor vanes turn through a definite angle, and as a result, brushes (3,10), installed on the balancing weights of each pair of vanes slide over [p 182] fixed potentiometers 2 (P_{21} in the sight circuit diagram) and 7 (P_{20} in the sight circuit diagram), changing the output voltage value.

Voltage received from potentiometer P_{20} of the angle-of-attack sensor is fed to the sight head potentiometer P_{18} which represents the receiving part of the servo-system which determines present angles of lag of the rocket. The yaw angle value is fed to the sight by means of potentiometer P_{21} of the yaw angle sensor.

In order to prevent icing of the vane and PVD mechanisms, heating elements are installed inside the tube. The heating elements are turned on at the same time as the PVD heating units through AZS "Heating of PVD, Clock" located in the aircraft cockpit on the instrument panel.

Current consumption at 27 v $\pm 10\%$ is:

- a) vane mechanism heating elements 2 to 3 a;
- b) combined with heating of the air pressure receiver 7 to 10 a.

Permissible power supply for angle-of-attack and yaw potentiometers is not more than 22 volts for the yaw angle potentiometer and not more than 30 volts for the angle-of-attack potentiometer. On the aircraft, the pickup potentiometers are supplied a stabilized voltage of 22 v through sight ASP-5ND.

The rod with DUAS-8M is installed on the aircraft in the plane of symmetry, and, in relation to the horizontal reference line, at [p 185] an angle of $-1^{\circ}30'$, as with other armament units. Maximum deflection angles of the vanes:

- a) $\pm 5^{\circ} 18'$ for the angle of yaw potentiometer;
- b) $--5^{\circ} 54'$ down and $\pm 17^{\circ} 42'$ up - for the angle-of attack potentiometer.

NOTE: The indicated maximum vane deflection angles correspond in flight to angles of yaw of $\pm 4^{\circ}30'$ and angles of attack of -5° to $\pm 15^{\circ}$.

The relative voltage between the potentiometer brush and its "minus" end changes linearly depending on the vane's angle of rotation.

The relative output voltage increases with deflections of the angle of yaw vane to the left, and the angle of attack vane -- upward, looking down and in the direction of the flight:

a) for yaw angles:

<u>Angle of yaw</u>	<u>Vane angle of rotation</u>	<u>Rated value of relative voltage in %</u>
$-4^{\circ}30'$	$-5^{\circ} 18'$	0
$-2^{\circ}15'$	$-2^{\circ}39'$	25
0	0	50
$+2^{\circ}15'$	$+2^{\circ}39'$	75
$+4^{\circ}30'$	$+5^{\circ}18'$	100

b) for angles of attack:

[p 186]

<u>Angle of attack</u>	<u>Vane angle of rotation</u>	<u>Rated value of relative voltage in %</u>
-5°	-5°54'	0
-3°	-3°32'	10
0	0	25
+3°	+3°32'	40
+6°	+7°05'	55
+10°	+11°48'	75
+15°	+17°42'	100

Relative voltage error must not exceed:

a) $\pm 2\%$ for angle of attackb) $\pm 3\%$ for angle of yaw

With the DUAS and the sight are correctly coupled, when the vane of the angle-of-attack sensor is deflected upward, the sight grid deflects downward; when the vane deflects downward, the sight grid deflects upward; when the vane of the angle-of-yaw sensor deflects to the right (looking in the direction of flight and down) the sight grid deflects to the left; when the vane deflects to the left, the sight grid deflects to the right.

Accuracy of DUAS installation must conform to the drawing for installation of the rod on the aircraft with a tolerance of $\pm 0^\circ 15'$.

[p 187]

Checking the angles of lag selected by the sight from the DUAS sensors is done by means of a device attached to the DUAS body and which gives angle-of-attack values of 2° ; 6° and angle of yaw

values of 1° ; 2° ; 3° . At the same time, the adjustable surfaces of the device adjoining the DUAS vanes are fixed beforehand by stops in position 0° and in deflected positions of $2^{\circ}22'$; $7^{\circ}05'$ for angles of attack and $1^{\circ}11'$; $2^{\circ}21'$; $3^{\circ}32'$ for angles of yaw, respectively, since the absolute values of angles of deflection of the vanes and angles of attack and yaw do not coincide (see tables).

3. AIRCRAFT INFRARED VIEWER SIV-52 FUNCTION

Aircraft infrared viewer SIV-52 is intended for detection of target aircraft at night in clear weather and for aiming at them using the infrared radiation of their aviation engines, i.e., by heat radiated by engine parts heated above 300° and which are not shielded in some way from observation by the fighter aircraft, such as jet nozzles, exhaust pipes, exhaust gases, etc.

The SIV-52 set consists of the following units:

- observing instrument SIV-52;
- power unit;
- high-voltage cable;
- optical element linking viewer OES-2 and sight ASP-5N.

Location of SIV-52 Units in the Aircraft

[p 188]

The observing instrument is located in the cockpit of the aircraft and is installed in place of gun camera SSh-45-1-100-OS on the bracket with the sight light filter. For rapid replacement of one

device by the other, the SIV and SSh mounting brackets have identical bases for the bolts by which they are attached to the light filter bracket.

The SIV-52 mounting bracket is attached by its base 1 (fig. 35) by means of two 6 mm (dia. bolts (3) to the bracket with light filter together with the sight head ASP-5ND through its clamps. The spherical collar of observing instrument 5 is placed into the bracket's ring 2; the latter's hinged part is secured tightly by screw 4 only after sight adjustment of the connected observing instrument, as indicated in the operating manual.

The optical axis of the installed observing instrument must be parallel to the sight line and must be located 90 ± 2 mm to the right of the aircraft's plane of symmetry and 32 ± 2 mm above the sight line. The center of the SIV-52 attachment ring is placed 28 mm to the rear of the optical axis of the sight collimator, which provides a gap between the device and the bulletproof glass, thus not interfering with pilot ejection.

The power unit is installed in the aircraft's cockpit on the right side behind the seat, near frame 11, above the horizontal datum line and is fixed in a vertical position in a clamp by means of tie bolts and anchor nuts.

[p 190]

The high-voltage cable, as well as the electrical wiring from the aircraft network to the power unit, are installed along the right side of the fuselage.

Observing Instrument

The observing instrument is a viewing tube with a special electron—optical instrument installed between the lens and the magnifier, which converts the infrared image formed by the lens to a small visible image which is observed through the 10-power magnifier.

The infrared ray beam arriving from the target (heated object) is focused by the lens on a semitransparent cesium oxide photocathode applied to the front glass of the electron-optical converter. Infrared rays striking the photocathode causes emission of electrons whose number per second is proportional to the intensity of flow of the infrared rays.

Under the influence of an electrostatic field of special shape created by the electron optics electrodes and acting as a lens, the flow of electrons from the photocathode is accelerated and focused similar to light rays on a fluorescent screen applied to the rear glass of the electron-optical converter.

Rays visible to the human eye are emitted by the fluorescent [p 191] screen at the points of impact of the electrons (the pilot sees them as an image when looking at the viewer.

The brightness of screen illumination is proportional to the density of flow of the electrons and their speed. The speed of the electron flow is determined by the value of the accelerating voltage (18 Kilovolts) applied between the anode and cathode of the electron-optical converter.

The density of flow of electrons depends on the illuminance of the viewer by infrared rays coming from the target. Lens illuminance decreases with an increase in target range and depends on the power of the infrared radiation source. The operating range of the viewer is determined by both aforementioned factors.

The operating range of the viewer at an altitude of 7-8 km against a medium bomber type aircraft in approaching from its rear is not less than 3-4 km. The field of vision is 23° . With a target range of approximately 2000 m, a multiengine target aircraft appears in the form of several dots (in accordance with the number of engines). At a greater range, the image of the engines blends into one point.

Optical Coupling Element OES-2

For aiming, an image of the moving center point of the sight grid is introduced (transposed) into the field of vision of the observing instrument SIV-52 by means of optical coupling element OES-2. OES-2 is fixed to the head of sight ASP-5ND installed [p 192] in the aircraft, and represents a periscopic tube consisting of lenses and prisms for transposing an image in mutually perpendicular planes (and magnifying them).

Power Pack

The high voltage needed for acceleration and focusing of the electron flow is produced by a special power pack.

The SIV-52 power unit is used to convert 115v, 400 cps a-c from converter PO-500A (see power supply for SIV-52) to 18 kilovolts d-c needed for the observing instrument.

The power unit consists of a high-voltage step-up transformer and a rectifier and voltage doubler tube circuit located in the housing.

The unit's housing is filled with transformer oil (960 cm³) which excludes the possibility of a discharge between the circuit elements. The unit's output is connected by high-voltage cable with the electron-optical converter of the observing instrument.

4. GUN CAMERA SSh-45-1-100-OS INSTALLATION

[p 193]

General Information

Gun camera device SSh-45-1-100-OS, equipped with time mechanism VM-2, is intended for photographing, and thus monitoring, the results of combat fire against aerial and ground targets, as well as for training purposes.

Time mechanism VM-2 keeps the gun camera circuit closed after release of the firing button and thus ensures operation of the device for an established period of time (up to 3 seconds).

Gun camera SSh-45-1-100-OS (FKN) photographs the combined image of the ASP-5ND sight grid and the target. FKP is

installed on the sight so that the sight grid is photographed in the light reflected by the sight reflector, and the target -- in direct light passing through the reflector of the sight collimator.

FKP is installed in the cockpit above the instrument panel, on the right, on the # 1 block of the ASP-5ND sight. The device is mounted on sight block # 1 by means of bracket 3 (fig. 36), tightly attached by two bolts 4 to the sight bracket (through the sight head clamps). The upper part of bracket 3 is made in the form of a spherical surface which is coupled to the FKP body by bolts.5. The spherical joint of the FKP installation allows movement of the device when being aimed. [p 195]

The mechanism VM-2 is installed in the cockpit on the right behind the instrument panel on the sight mounting bracket by means of two angle brackets 9 (fig. 37), which are attached to the ribs of the bracket. The VM-2 housing is attached by its bolts to anchor nuts on the angle brackets.

Basic Technical Data on SSh-45-1-100-OS

Optical Data

- | | | |
|---|----------------------|---------|
| 1. Lens system | four-lens, type F455 | |
| 2. Maximum relative aperture | 1:56 | |
| 3. Focal distance | 100 mm | [p 196] |
| 4. The objective is equipped with an iris diaphragm allowing smooth change of the relative aperture of the lens and stopping to relative apertures of 1:56; 1:8; 1:11 | | |
| 5. Field of vision | 14°15' x 19°18' | |

Structural data

1. Film used standard, 35 mm, perforated on both edges in accordance with GOST 4898-56
2. Frame size 34 x 25 mm
3. Distance from grid cross lines to the scale line 10 mm
4. Photographing speed at 27 v $\pm 10\%$ 5 $\pm$ 1 frames/sec
5. Film supply in one cassette 3.6 m
6. Number of frames in one cassette 97
7. Rated continuous photographing time at 27 v 9.7 sec
8. Exposure time (permanent) 1/50 sec
9. Dimensions of gun camera with prismatic attachment (lens F=100 mm) 213 x 107.5 x 74 mm
10. Operational temperature range of the camera with heating -60° to +50° C
11. Permissible overloads during operation 3.5 at frequency of 200 cps

12. Instrument is capable of withstanding
the following number of short-term
overloads without breakdown

up to 6 at fre-
quencies up to
200 cps

Electrical Data

- | | |
|----------------------------------|---|
| 1. FKP power supply | from d-c network of
27v $\pm 10\%$ |
| 2. Electric motor | DK-12B, shunt type. |
| 3. Number of revolutions at 27 v | 8600 rpm |
| 4. Current consumption | not more than 1.3 a with
power of 36w $\pm 10\%$ |
| 5. Rated power | 10 w |
| 6. Heating of FKP | 36w $\pm 10\%$ electric heater, [p 197] |
| 7. Heater thermoregulator | bimetal type, turns on
heater automatically
when temperature drops
to $+3^{\circ}$, and turns it off
when temperature reaches
$+30^{\circ}$ C |

Basic technical data of time mechanism VM-2

- | | |
|--------------------------------|--------------------------------------|
| 1. Time setting | 0 to 3 seconds |
| 2. Dimensions of the mechanism | 91 x 80 x 158 mm |
| 3. Weight | 1.2 kg |
| 4. Power supply | from the aircraft
network, + 27 v |

5. Current consumption at +27v $\pm 10\%$

- | | |
|-----------------------|----------------------|
| a) by electric heater | not more than 1.32 a |
| b) by electromagnet | not more than 2.05 a |

The SSh-45-1-100-OS set

The FKP set includes:

- | | | |
|--|-------|---------|
| 1. The camera with floo lens and prismatic attachment with cover glass | 1 set | |
| 2. Operating film cassette | 2 ea. | |
| 3. Practice fire cassette | 1 ea. | [p 198] |
| 4. Spare parts, tools, and miscellaneous parts. | | |

SSh-45-1-100-OS design

The FKP consists of the following basic units: camera, operating cassette, plug connector, and lens with prismatic attachment.

The FKP camera consists of a housing with cover in which the following basic units and parts are installed (fig 38): electric motor 5, shutter 11, operating cassette with spools 3, 22 and film winder 6, gear system 9, 15, 12, and 10 transmitting the electric motor action to film winder 6, and shutter 11. In addition, a heater resistor and thermoregulator are also installed in the housing.

Shutter 11 is a cylinder with one opening for the passage of light (coming from the lens), which is attached to gear 15 by

screws. When electric motor 5 turns, its movement is transmitted through gear 9 to gear 15 which rotates jointly with shutter 11 and transmits the action to "Maltese cross" sprocket 13. The "Maltese cross" sprocket, while turning, transmits the rotating action through gears 12 and 10 to film winder 6 of the operating cassette. Thus, rotation of gear 15 causes continuous rotation of shutter 11 and intermittent rotation of the "Maltese cross" sprocket 13. During one full revolution of the shutter, one frame is photographed, and the "Maltese cross" sprocket revolves twice. The length of time during which sprocket 13 and, consequently, the film are stationary between turns differs. The shutter aperture is made so that photographing of a frame occurs at the time of the longest stationary period of the film. Turning of film winder 6 transmits action through roller 7 and friction drive 8 to drive spool 3, thus rewinding the film from driven spool 22.

[p 199]

As the diameter of the film roll on driving spool 3 increases, the linear speed of the film also increases and its speed on winder 6 remains the same. The spring friction transmission by means of friction drive 8 allows spool 3 to slip, thus adjusting the speed of film rotation on spool 3 and winder 6 and eliminating the possibility of tearing the film. Driven spool 22 is connected to coupling shaft 23 of the disc indicator located on the outside of FKP. Turning of spool 22 also turns the indicator disc which shows motion of the film during operation of FKP.

NOTE: The design of the device provides for sending a return signal, not used on this particular type of aircraft (see fig. 38, pos. 17).

For conducting adjustment fire, an adjustment fire film cassette [p 200] is provided with gun camera FKP and is installed in the same manner during adjustment fire as the operating film cassette.

FKP Optical System

The SSh-45-1-100-OS optical system is intended for photographing the object's (target) image and the sight grid on ordinary 35-mm film.

The FKP optical system (fig. 39) consists of the target photographing lens system 2, the instrument's grid 3, and removable prismatic attachment 1 consisting of one prism.

The lens for photographing the target has a focal distance of 100 mm and maximum relative aperture of 1:5.6. It is equipped with an iris diaphragm allowing smooth relative aperture changes.

The grid of the instrument is a glass plate with cross lines and a scale line. The cross lines are used for adjustment fire of the FKP. The scale line is used for determining the scale in interpretation of the photographs.

Construction of time mechanism VM-2

[p 202]

Time mechanism VM-2 is a box on top of which are mounted:

- mechanism with an electromagnet which provides fixed time intervals;
- switch P_2 providing for operation of FKP with or without VM-2;
- switch P_1 providing automatic disconnection of FKP after a definite time interval determined by control handle of VM-2;
- electric heater with thermoregulator for heating VM-2 mechanism in low temperatures.
- four-pin plug connecting VM-2 with FKP;
- three-pin plug connecting VM-2 with the aircraft line and the fire control button.

[p 203]

When the firing button is pressed, the aircraft line voltage is fed to electromagnet 1 of VM-2 (fig. 40). Electromagnet 1 pulls in core 2 which in turn pulls segment gear 4 by means of pull rod 3, winding spring 12 through gear 10. Shaft 5 turns and leads screw 7 away from rod 8 of switch 9 (P_1 in fig. 30), which, through contact 25 (K_2 in fig. 30), closes the circuit; this feeds power to the FKP electric motor (M in fig. 30). At the same time, contact 24 (K_1 in fig. 30) opens and the FKP heating circuit opens. Upon release of the fire control button, voltage supply to the VM-2 electromagnet stops and mechanism VM-2 begins to operate for the established time interval. Pulled by spring 12, gear 10 and segment gear 4 rotate, the latter pulling out core 2 by means of pull rod 3. Lever 11, rigidly connected with gear 10, returns to its initial position, but pawl 13 catches the teeth of ratchet wheel 14 and turns it evenly.

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Even turning is ensured by an anchor mechanism (gear 21 and shifting fork 22) through gears 18, 19, 20). Lever 11 continues to turn until pawl 13 hits disc cam 15 which disengages it from ratchet wheel 14. At this point the anchor mechanism becomes disengaged while lever 11, by the action of spring 12, is pushed to its initial position. Screw 7 presses against rod 8 of the switch and opens contact 25 (K_2 in fig. 30); the FKP electric motor is turned off and FKP ceases to function; contact 24 (K_1 in fig. 30) closes and turns on the FKP heater. Disc cam 15 connected to handle 16 is turned by the latter when changing the operating time to the mechanism. Handle 16 moves along scale 17 which is graduated in seconds. The position of handle 16 is fixed by segment gear 26, rigidly attached to the handle's shaft, into whose serrations ball 28 is pressed by spring 27. Fork 23 serves for preliminary adjustment of the tension of spring 12. [p 205]

Control of gun camera SSh-45-1-100-OS

The gun camera control (Fig.30) is remote and electrical and is directly connected with control of gun fire and rocket launching.

In addition to the circuit breakers and switches of the above-mentioned armament control systems, which must be placed in the appropriate positions, the following elements are included in the gun camera control system: [p 206]

S-E-C-R-E-T

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- AZS [circuit breaker] -5 "FKP" - 8 (19P), serving as a safety device for FKP circuits, providing power to FKP and VM-2 heaters, and switching on the instruments through relays;

- fire control and FKP relay 9 (28P);
- missile launching and FKP circuits relay 14 (fig. 20) (41P);
- gun camera time mechanism VM-2 1 (fig. 30);
- firing button 11 installed on the control stick handle.

To use the gun camera while firing the gun or launching rockets, AZS "FKP" must be turned on.

Operation of FKP electrical control circuit

When AZS "FKP" 8 (fig. 30) is turned on, the aircraft network voltage of +27 v is fed to:

- thermoregulators T_2 of time mechanism 1 and T_1 of gun camera 5, and through them (depending on temperature; see below) to heating elements O_2 of the time mechanism and O_1 of the gun camera; [p 207]

- normally open contacts of fire control relay 9 and rocket launching relay 14 (fig. 20).

To turn on the FKP it is necessary to press firing button 11 (fig. 30). This triggers the fire control relay or the rocket launching relay, sending +27v through its closed contacts and through time mechanism terminal "3" to switch P_2 , which ensures gun camera operation with or without time lag, as indicated below.

Operation of the electrical components of time
mechanism and gun camera with time delay

In this case, the time interval of FKP operation following firing button release is previously established by the position of the VM-2 handle. Placed in position "On" also beforehand Time mechanism switch P2 is first placed in the "On" position, closing contact K_3 (fig. 30).

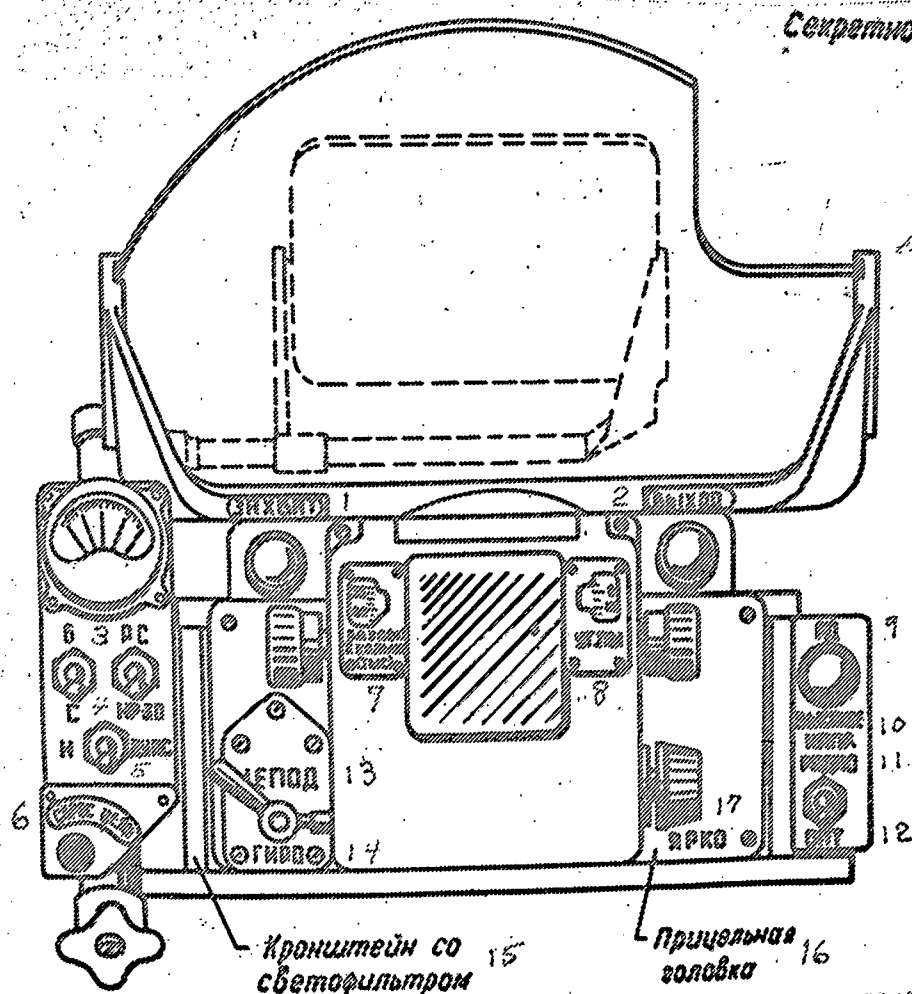
The voltage sent to thermoregulator T_2 when AZS "FKP" is turned on, when the temperature is below -2°C , is fed by its closed contacts to time mechanism heater O_2 , and at temperatures above $+15^{\circ}\text{C}$, the thermoregulator is automatically cut off. Voltage is fed through closed contacts K_1 of time mechanism switch P_1 to FKP thermoregulator T_1 , whose contacts close at temperatures below $+3^{\circ}\text{C}$ and open at temperatures above $+30^{\circ}\text{C}$, turning on and off the FKP heater O_1 .

[p 208]

The voltage applied to switch P_2 of VM-2 when the firing button is pressed is fed through closed contact K_3 to the coil of electromagnet 3; the magnet operates and closes contact K_2 , turning on electric motor M and breaking the heating circuit. The electric motor activates the FKP mechanism. Upon release of the firing button, fire control relay 9 (or rocket launching relay) releases and voltage to magnet "E" of VM-2 ceases. After an established period of time the electromagnet core opens contact K_2 , disconnecting the FKP electric motor, while contact K_1 closes and turns on the FKP and VM-2 heater.

Fig. 31. Location of switches and signal lights on bracket with light filter and sight head ASP-5ND

1-lock on; 2-withdraw; 3-rocket; 4-gun; 5-DUAS; 6-target release; 7-base of ring (thousands); 8-angles; 9-range only radar; 10-high voltage; 11-radio; 12-optics; 13-fixed; 14-gyro; 15-bracket with light filter; 16-sight head; 17-brightness



Фиг. 31. Установка переключателей и сигнальных ламп на кронштейне со светофильтром и головке прицела

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АСП-5НД

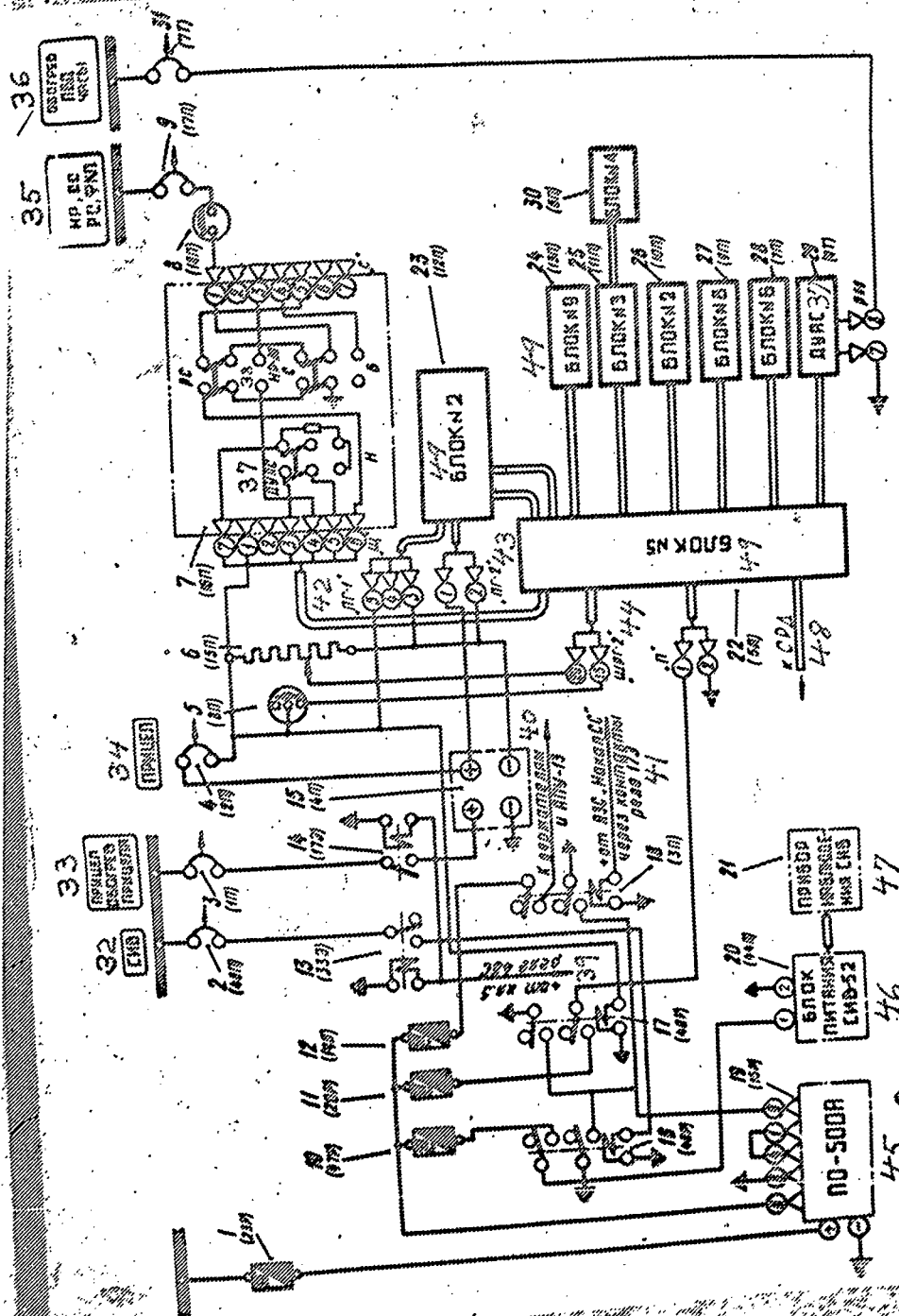


Fig. 32. Schematic electrical diagram of power supply for ASP-5ND sight, SIV-52 viewer, DUAS-8M sensor, and sight control.

Fig. 32. Schematic electrical diagram of power supply for ASP-5ND sight, SIV-52 viewer, DUAS-8M sensor, and sight control.

1-time delay IP-50 in converter PO-500A starting circuit; 2-AZS-4 circuit breaker in viewer SIV-52 supply circuit; 3-AZS-20 circuit breaker in sight heating circuits; 4-AZS-10 circuit breaker in sight circuits; 5-sight damping button; 6-manual range introduction potentiometer; 7-sight selector switch panel; 8-firing button; 9-master circuit breaker AZS-5 in armament control circuits; 10-fuse SP-5; 11-fuse SP-5; 12-fuse SP-5; 13-high-current apparatus relay (blocking); 14-high current apparatus relay (blocking); 15-radio noise filter F-14A; 16-SIV-52 power supply relay TKYe-52PD; 17-relay TKYe-52PD for a-c power to sight; 18-relay TKYe-52PD for a-c power to K-13 missiles; 19-converter PO-500A; 20-power supply for SIV-52; 21-SIV-52 observing instrument; 22-sight control box; 23-sight head ASP-5ND; 24-voltage stabilizer for ASP-5ND; 25-zero gyroscope for ASP-5ND; 26-ASP-5ND computer; 27-ASP-5ND electronic relay; 28-ASP-5ND altitude indicator; 29-angle of attack and yaw sensor DUAS-8M; 30-ASP-5ND zero gyroscope amplifier; 31-AZS-20 circuit breaker for heating DUAS and clock; 32-SIV; 33-sight-sight heating; 34-sight; 35-gun, missiles, rockets, gun camera; 36-heating PVD, clock; 37-DUAS; 38-NR-30 [gun] ; 39- + from terminal 5 of relay 46S; 40-to pylon and APU-13; 41- + from "Missile Filament" circuit breaker through contacts of relay 17E; 42-"PG-1"; 43-"PG-2"; 44-"ShRG-2"; 45-PO-500A; 46-SIV-52 power supply; 47-SIV observing instrument; 48-range-only radar; 49-blocks.

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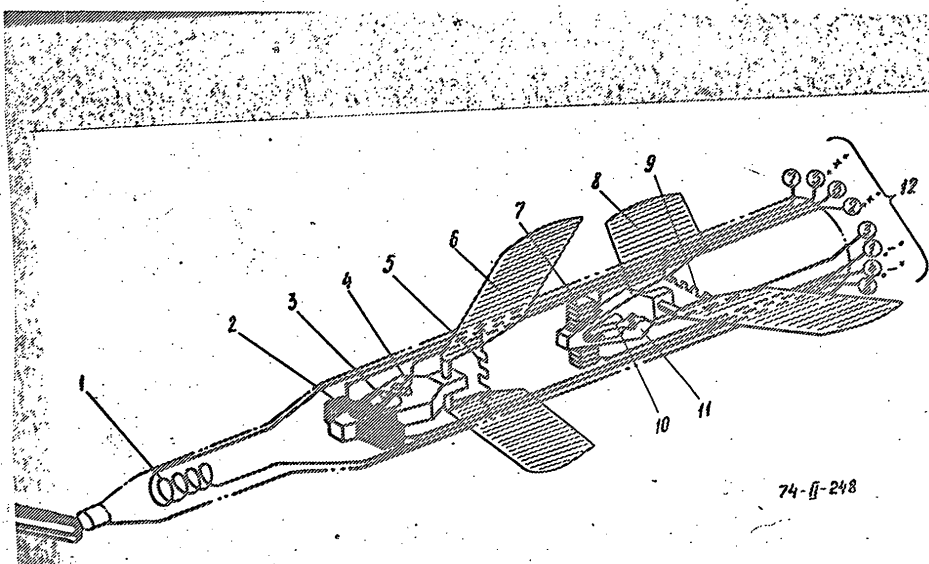


Fig. 33. Electromechanical diagram of sensor DUS-3M

1-PVD heater; 2-yaw angle potentiometer; 3-potentiometer sliding contact; 4-balancing capacitance; 5-heater for yaw sensor vane; 6-yaw angle sensor vane; 7-angle of attack potentiometer; 8-angle of attack vane; 9-heater for angle of attack sensor; 10-potentiometer sliding contact; 11-balancing capacitance; 12-plug connector.

Fig. 33. Электромеханическая схема датчика ДУАС-3М.

1 - обогрев ПВД; 2 - потенциометр угла скольжения; 3 - ползунок потенциометра; 4 - противомес; 5 - обогрев датчика угла скольжения; 6 - флажок датчика угла скольжения; 7 - потенциометр угла атаки; 8 - флажок датчика угла атаки; 9 - обогрев датчика угла атаки; 10 - ползунок потенциометра; 11 - противомес; 12 - электроразъем.

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Fig. 34. Schematic electrical diagram of DUC-8M (positions same as in Fig. 33)
1-PVD heater; 2-yaw angle potentiometer; 3-potentiometer sliding contact; 5-heater for yaw angle sensor; 7-angle of attack potentiometer; 9-heater for angle of attack sensor; 10-potentiometer sliding contact.

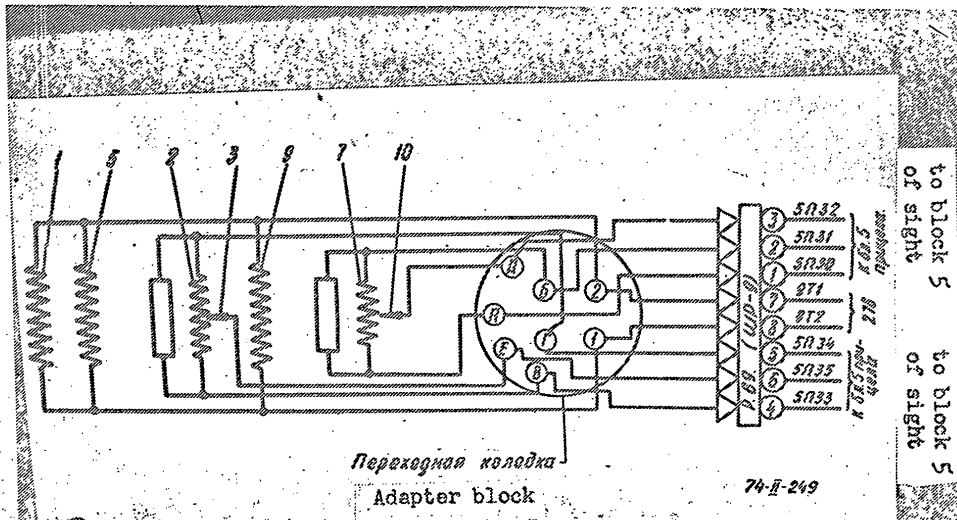


Fig. 34. Schematic electrical diagram of DUC-8M (positions same as in Fig. 33).

1 - PVD heater; 2 - potentiometer yaw angle; 3 - potentiometer sliding contact; 5 - heater yaw angle sensor; 7 - potentiometer angle attack; 9 - heater angle attack; 10 - potentiometer sliding contact.

Fig. 35. Observing instrument of SIV-52 viewer

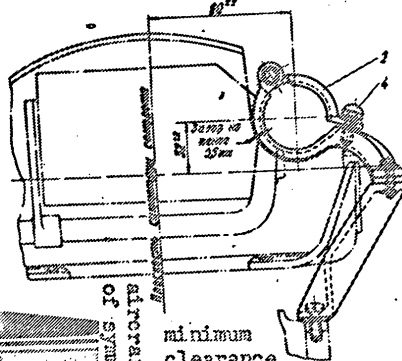
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1-bracket base; 2-bracket clamp; 3-sight bracket-to-base bracket attachment belts; 4-tie bolt; 5-SIV-52 observing instrument; 6-optical coupling element OES-2.

view in the direction of arrow "A"

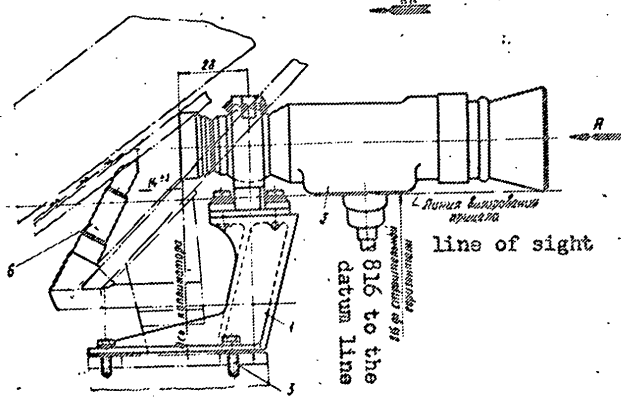
Вид по стр. А
(прямой прибор SIV-52 и элемент ОЭС-2
установлены по показаниям)



minimum
clearance
2.5 mm

of symmetry
aircraft's plane

direction of flight



line of sight

816 to the
datum line

collim-
mating
axis

Fig. 35. Установка прибора наблюдения дивера SIV-52.

1 - основание кронштейна; 2 - хомут кронштейна; 3 - болты крепления кронштейна к кронштейну планера; 4 - винт затяжной; 5 - прибор наблюдения SIV-52; 6 - оптический элемент сопряжения ОЭС-2.

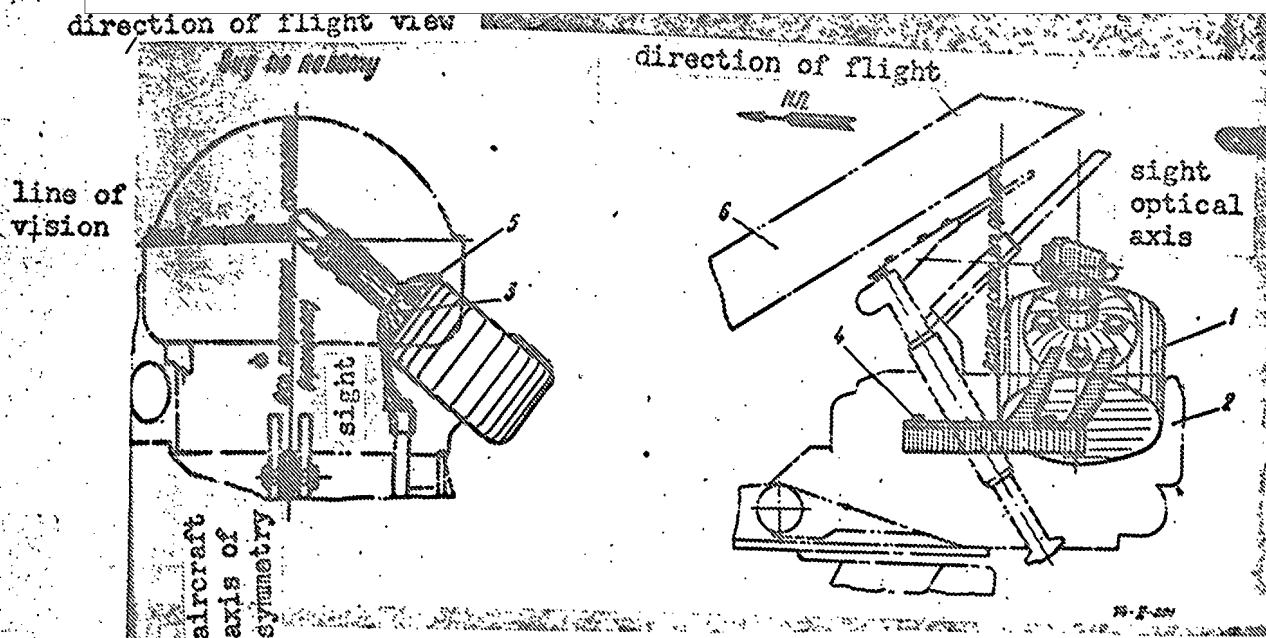


Fig. 36. Gun camera SSh-45-1-100-OS installation

1-gun camera SSh-45-1-100-OS; 2-sight head; 3-bracket; 4-bracket attachment bolt; 5-gun camera to bracket attachment bolt; 6-bulletproof glass.

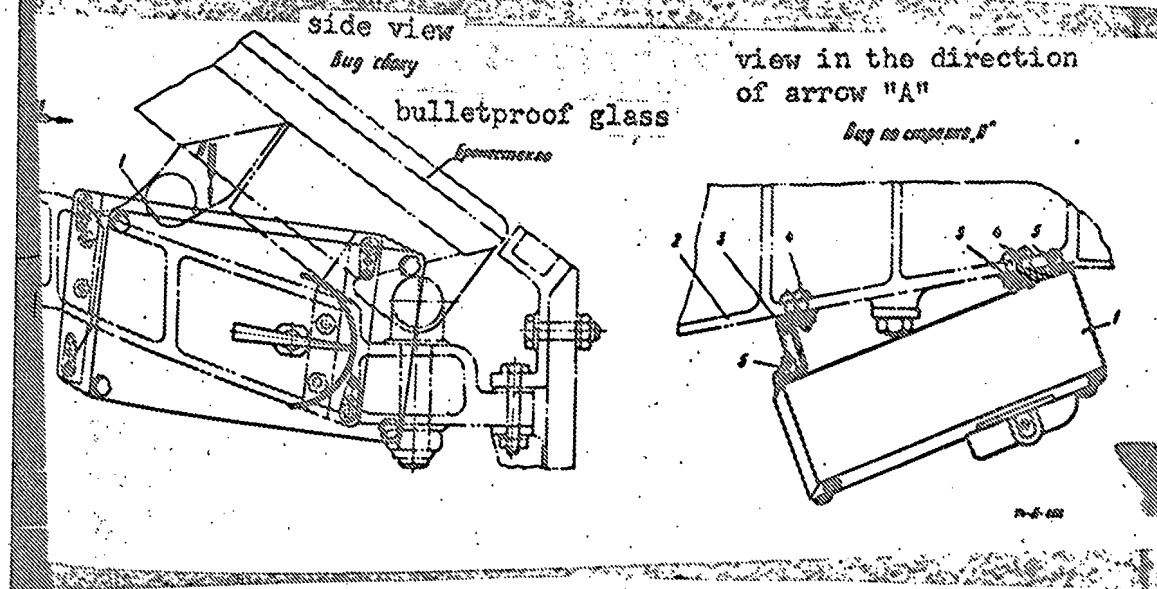
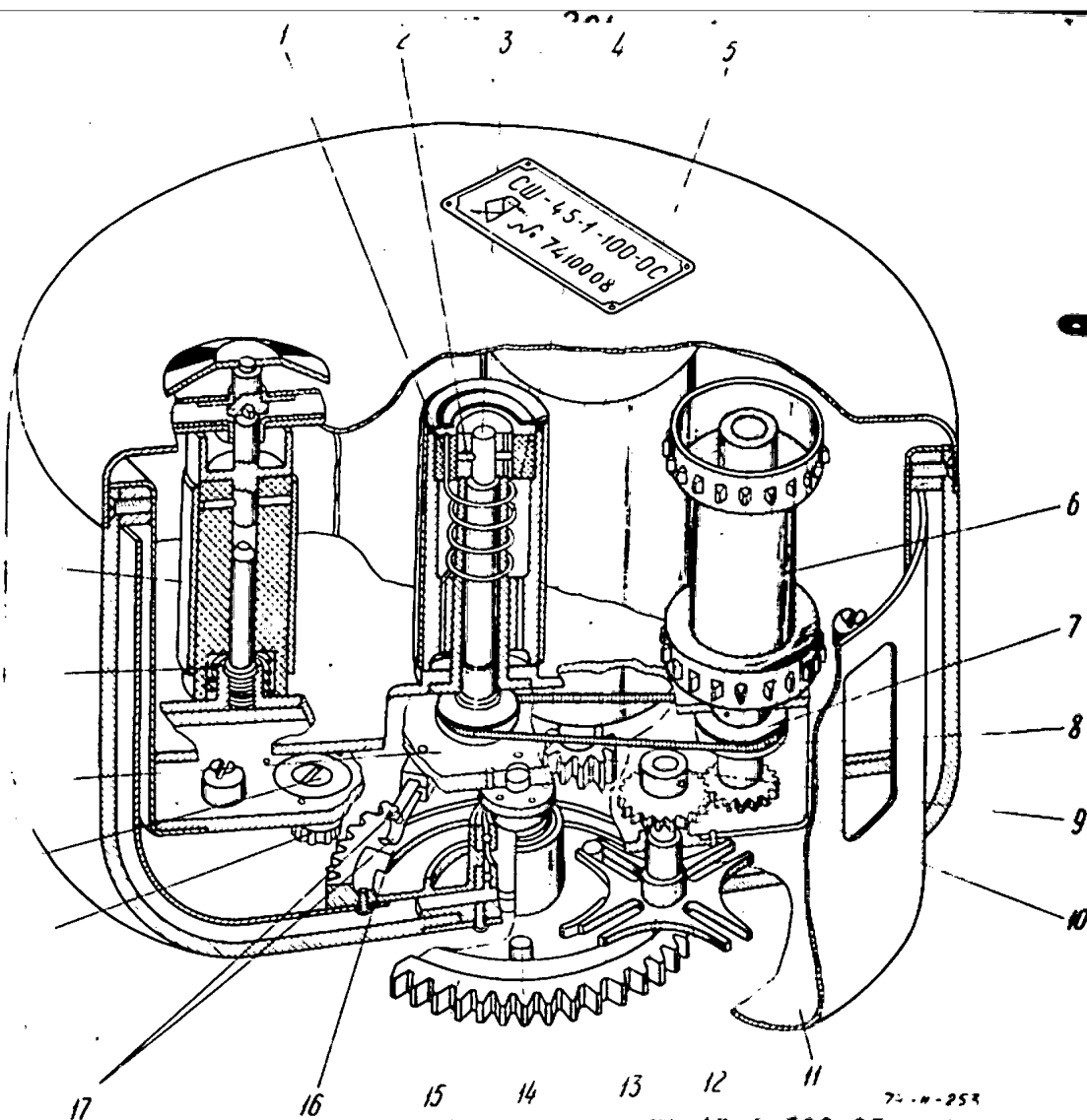


Fig. 37. Time mechanism VM-2 installation

1-time mechanism VM-2; 2-sight mounting bracket; 3-angle; 4-screw; 5-anchor nut.



Сиг. 38. Сиг. 45-1-100-0С

/конструкция в разрезе/.

- 1-шайба; 2-палец; 3-ось звуковой катушки; 4-пружина;
 5-электродвигатель; 6-лентопротяжной барабан; 7-ролик;
 8-пружинный тросик; 9-шестерня; 10, 15, 17, 18-зубчатые
 колеса; 11-оборотовый; 12-малый крест;
 13-штифт; 14-кулачок; 15-контакт отщелкнутого сигнала
 /не используется/; 16-ось зубчатого колеса для
 поворота механизма вручную; 17-пластинка; 18-пружина;
 19-звуковая катушка; 20-муфта сигнального диска.

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Fig. 38. Gun Camera SSh-45-1-100-OS

1-washer; 2-cam; 3-drive spool; 4-spring; 5-electric motor; 6-film winder; 7-roller; 8-friction drive; 9-driving gear; 10, 12, 15, 18-gears; 11-shutter; 13-"Maltese cross" sprocket; 14-pin; 16-cam; 17-re-sponding signal contact (not used); 19-gear shaft for turning the mechanism manually; 20-platform; 21-spring; 22-driven spool; 23-coupling shaft of disc indicator.

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50X1-HUM

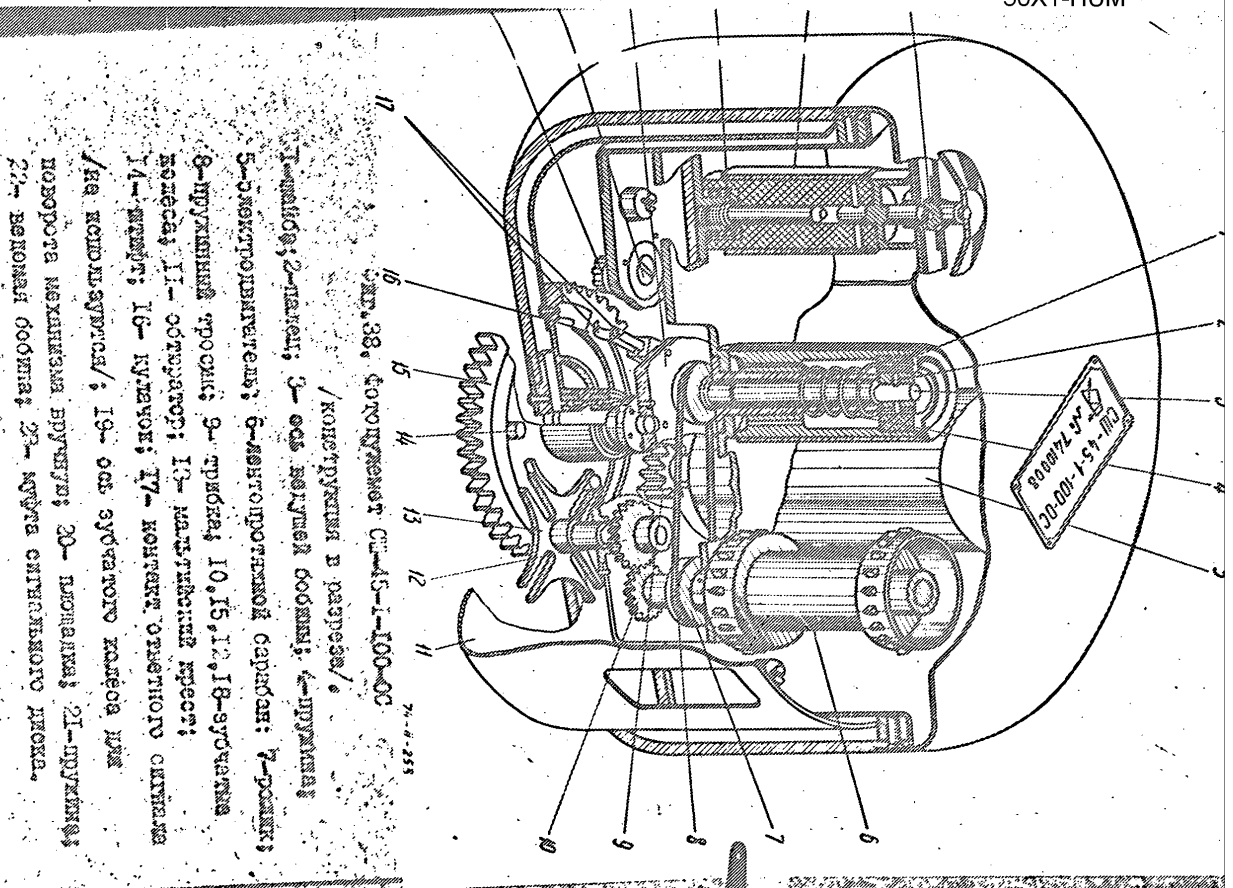
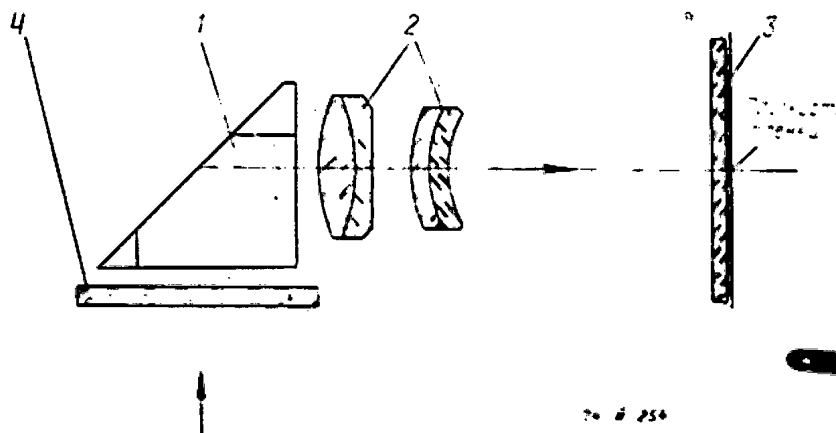


Fig. 38. Gun Camera SSh-45-1-100-OS

/конструкция в разрезе/

1-шайба; 2-шестерня; 3-ось ведущей катушки; 4-пружина;
5-электродвигатель; 6-механизм с обратной катушкой; 7-ручка;
8-пружинный трояк; 9-трояк; 10, 12, 15, 18-зубчатые
колеса; 11-шатун; 13-малtese крест; 14-шпиль;
16-шестерня; 17-контактный элемент; 19-ось
ручки для поворота механизма вручную; 20-платформа;
21-пружина; 22-ведущая катушка; 23-ось сцепного диска.



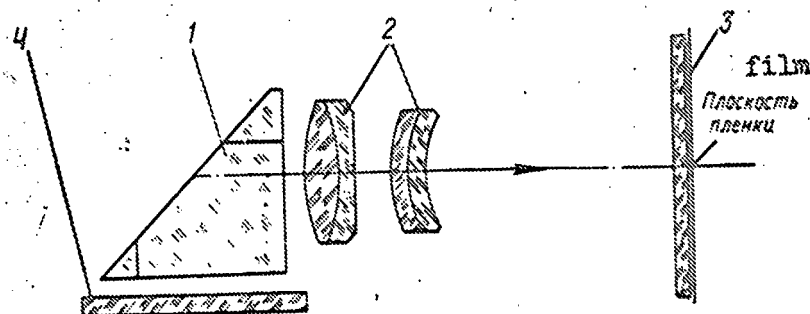
Фиг. 89. Оптическая схема СБ-45-I-100-ОС.

1- съемная призматическая насадка; 2- объектив;
3- сетка прибора; 4-защитное стекло или
светофильтр.

Конструкция временного механизма М-2

Временной механизм М-2 предстает собой
коробку, на плите которой смонтированы:

- механизм с электромагнитом, отсчитывающий
установленное время;
- переключатель П₁, обеспечивающий работу СКИ
с М-2 или без него;
- переключатель П₂, обеспечивающий автоматическое
отключение СКИ через установленный рукоят-
кой М-2, определенный промежуток времени;
- электропечь с терморегулятором для обогрева
механизма М-2 при низких температурах;



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Fig. 39. SSh-45-1-100-OS optical system

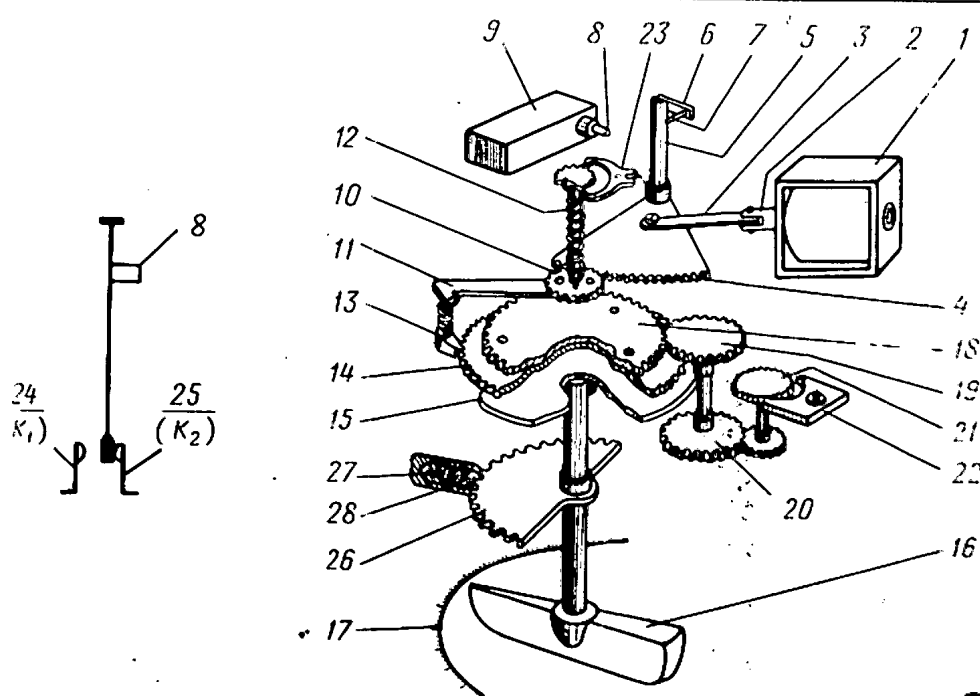
1-removable prismatic attachment; 2-lenses; 3-grid;
4-protective glass or light filter.

светофильтр.

Конструкция временного механизма ММ-2

Временной механизм ММ-2 представляет собой коробку, на плиту которой смонтированы:

- механизм с электромагнитом, отрабатывающий установленное время;
- переключатель Π_2 , обеспечивающий работу ОКП с ММ-2 или без него;
- переключатель Π_1 , обеспечивающий автоматическое отключение ОКП через установленный рукояткой ММ-2, определенный промежуток времени;
- электропечь с терморегулятором для обогрева механизма ММ-2 при низких температурах;



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Фиг. 40. Конструкция временного механизма

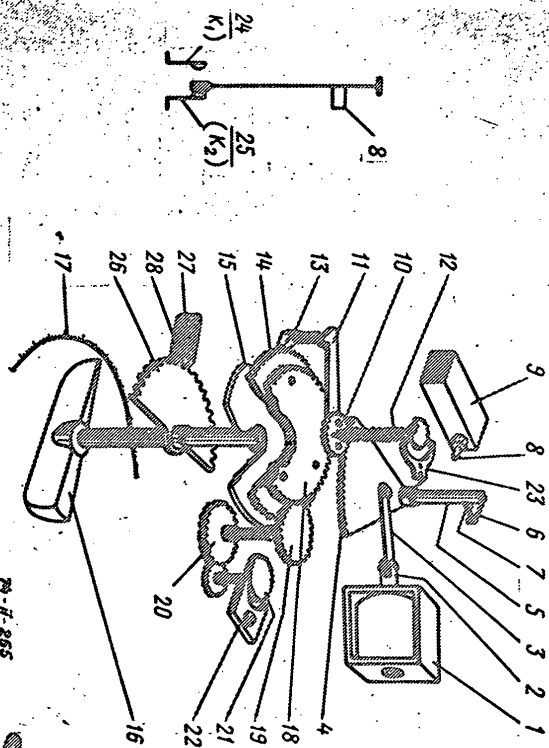
ИИ-2 /кинематическая схема/.

- 1- электромагнит; 2- сердечник; 3- тяга; 4- зубчатый сектор; 5- ось; 6- кривошип; 7- штифт; 8- шток переключателя; 9- переключатель; 10, 18- шестерня; 11- рычаг; 12- заводная пружина; 13- собачка; 14- храповое колесо; 15- дисковый кулачок; 16- рукоятка; 17- шкала; 19-20- паразитная шестерня; 21- колесо анкера; 22- вилка анкера; 23- вилка; 24, 25- контакт; 26- зубчатый сектор; 27- пружина; 28- шарик;

Fig. 40. Construction of Time Mechanism VM-2 (Functional Diagram)

1-electromagnet; 2-core; 3-pull rod; 4-segment gear; 5-shaft; 6-shaft arm; 7-screw; 8-switch rod; 9-switch; 10, 18-gears; 11-lever; 12-winding spring; 13-pawl; 14-ratchet wheel; 15-disc cam; 16-disc cam; 17-scale; 19, 20-idle gear; 21-anchor wheel; 22-anchor fork; 23-fork; 24, 25-contacts; 26-segment gear; 27-spring; 28-ball.

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S-E-C-R-E-T

Operation of electrical components of VM-2 and SSh-45-1-100-OS
without time delay (with VM-2 disconnected)

In this case, operation of gun camera SSh-45-1-100-OS ceases simultaneously with release of the fire control button.

Time mechanism switch P_2 is first placed in position "Off"; contact K_4 closes, contact K_3 opens. When firing button 11 is pressed, +27v is sent from terminal "3" of VM-2 through closed contact K_4 to the FKP electric motor which actuates mechanism SSh-45-1-100-OS. The FKP heater circuit is turned on and is supplied through contact K_1 which is closed, since magnet "E" in this situation is de-energized. Upon release of the firing button, the button contacts and fire control relay open and power supply to the FKP electric motor ceases, thereby stopping photography. The FKP and VM-2 heating circuits remain on.

CHAPTER VII.

[p 210]

SEAT "SK" AND EJECTION FIRING MECHANISM

(Brief information)

1. BRIEF INFORMATION ON SEAT "SK"

Seat "SK" is part of the ejection system intended for saving the pilot in emergency conditions in flight at low as well as high speeds.

The cockpit canopy is used to protect the pilot from the effect of onrushing air in ejecting the pilot with seat "SK". As a consequence, braking overloads are reduced by the increase in total weight of the dropped system (seat and canopy). Seat "SK" provides for exit of the pilot from the aircraft by means of a single motion (pressing the trigger levers of

the seat arms), easily executed in any flying conditions in an emergency. The seat provides a simplified means of securing the pilot by using a unified attachment system and guarantees that the pilot assumes the position necessary for ejection by forced strapping.

Typical features of seat "SK" are the initiators which are parts of the corresponding seat control systems (fig. 41): the stabilizing parachute release initiator ("215P"), two canopy release initiators ("215F"), and initiator for tightening pilot's shoulder harness ("215R").

Seat stabilizing parachute initiator "215P" is installed [p 212] behind seat "SK" in its upper part and is attached at one end by bolts to the vertical sections of the seat frame, and at the other end--by a bolt connecting the pin head at the bottom of the initiator with the seat structure.

The canopy jettison initiators "215F" are installed on sections of seat "SK" guide-rails on the left and right. The initiators are attached by bolts through pin heads to brackets in the lower part of the seat tracks at one end, and by two-arm canopy jettison lever at the other.

Initiator "215R", for tightening the shoulder harness is installed on the left seat track of seat "SK" and is attached by means of two clamps secured by bolts to the seat track. The lower clamp serves as guide for the initiator's outer cylinder when it moves.

2. SEAT CATAPULT TELESCOPING DEVICE TSM-2500-38

General information

Telescoping firing mechanism TSM-2500-38 installed in the aircraft is intended for ejection of seat "SK" with pilot (with or without protection by canopy) in case of emergency in flight.

Ejection is accomplished by converting energy developed by [p 213] the burning of the powder charge of the firing cartridge into kinetic energy of the seat.

The telescoping firing mechanism is actuated by the pilot by pressing on the trigger levers of the seat arms. The action is transmitted by way of cables and pull rods to the rod which pulls out the locking pin of TSM-2500-38 and actuates the bolt of the telescoping firing mechanism.

The telescoping firing mechanism consists of four concentric extension-type cylinders 8, 9, 11, and 12 (fig. 42) equipped with a two-pin bolt, a ball lock, and two attachment clamps. In addition, the mechanism has a special bleed device installed in the boss of the ball lock housing of the mechanism, which opens in case of ejection with independent canopy drop. Internal cylinder 12 is connected by a hinge with seat "SK". External cylinder 8 is connected by a hinge with the aircraft structure.

The TSM-2500-38 mechanism is equipped with a 38 mm explosive charge PK-16. The use of a fourth cylinder provides for an increase in operating travel to 2500 mm, which is especially important in ejection at high flight speeds.

Telescoping firing mechanism TSM-2500-38 has a two-pin bolt and is used with a two-percussion cap cartridge, thus increasing the reliability of the mechanisms operation. Construction of TSM-2500-38 provides for removal and installation of the bolt and the cartridge without stripping the firing mechanism from the aircraft, thus facilitating its exploitation (when the seat is not installed in the aircraft).

TSM-2500-38 technical data

1. Length of travel of the mechanism 2500 mm
2. Type of firing cartridge PK-16
3. Cartridge caliber 38 mm
4. Weight of the assembly 12.7 ± 0.5 Kg
5. Dimensions:
 - a) length 1120 mm
 - b) maximum cross-section diameter 72 mm
 - c) attachment trunnion diameter $15C_3$
6. Protrusion of firing pins 1.4 - 1.8 mm
7. Locking pin travel ~ 18 mm
8. Length of mainspring in released condition . . 52 ± 2.5 mm
9. Main spring minimum tension when compressed to
length of 21 mm 8.5 kg
10. Bleed opening diameter $4.5A_3$
11. Travel of bleed device pin ~ 35 mm
12. Diameter of bleed opening nozzle $3.2A_3$

Construction of TSM-2500-38

(Fig. 42)

Outside cylinder 8 is a tube with threads for connection to socket 7, clamp 10, and the body of ball lock 13.

Middle cylinder I (9) is a tube with an inside expansion on its upper part (which serves as a stop for middle cylinder II (11)) and an outside expansion (with gas escape slits) which serves as a stop for middle cylinder I.

Middle cylinder II (11) is a tube with an outside expansion on its lower part (which serves as stop resting against the inside expansion of cylinder 9) with gas escape slits.

Inside cylinder 12 is a stepped tube with threads on its upper enlarged end for joining with clamp 4, and with two rows of holes in its lower enlarged end. The lower row holes have lock balls 15 placed in them, while the upper row holes serve to pass gas through into the space between outside cylinder 8 and middle cylinder I (9).

Two-pin bolt is used for locking the mechanism for firing, holding the firing cartridge, and firing when the locking pin is pulled. The bolt consists of the following basic parts: body 5, two-pin firing pin [p 218] assembly 6, main spring 3, head 1, and locking pin 2.

The ball lock with bleed device serves to prevent shifting of seat "SK" during various maneuvers of the aircraft and seals the mechanism's lower end during firing.

The bleed device is intended for letting out excess powder gas in an independent canopy jettison.

The ball lock with scouring device consists of the following basic parts: body 13, clip 14, piston 16, spring 17, and balls 15. Body 13 has a boss which holds the bleed device, consisting of plunger 20, diaphragm 21, spring check pin 19, and nut 18.

Operation of TSM-2500-38 during firing

Operation of the seat arm trigger levers by the pilot causes locking pin 2 to be pulled from the firing mechanism's head 1. The released firing pin assembly 6, subjected to pressure of main spring 3 punctures the explosive cartridge percussion caps. This causes the igniter and then the main charge of the cartridge to ignite. The firing cartridge blows open from powder gas pressure. Powder gas spreads through the hollow of inside cylinder 12 and then through the holes in the cylinder and through slits 9 and 11, entering the space between cylinders 8 and 9.

Pressed by the powder gas, the ball lock piston moves downward, releases balls 15, and pressing against the bottom of the lock's body, seals the lower part of the mechanism. Cylinders 9, 11, and 12 begin to move upward together with seat "SK". Cylinder 9 reaches the stop in the expansion of socket 7 and stops. Cylinders 12 and 11 continue moving upward until the expansion of cylinder 11 reaches the shoulder of the expansion of cylinder 9; cylinder 11 stops while cylinder 12 is pushed out by powder gas pressure and carries with it the catapulted seat.

When the pilot is forced to jettison the canopy separately, check pin 19 of the bleed device is pulled and plunger 20, under powder gas pressure, seats itself as far as the stop and opens the bleed holes. At the same time, excess gas pushes out diaphragms 21 and escapes.

3. "215P" INITIATOR FOR EJECTION OF STABILIZING PARACHUTE

General information

Initiator "215P", installed on catapulted seat "SK", is intended for ejecting into the air stream and holding the parachute used for stabilizing the position of seat "SK" with the pilot during catapulting.

Initiator "215P" is a telescoping device made of four concentrically located cylinders 13, 14, 15, and 16 equipped with bolt, clamps, lock, and pull rods. (fig. 43)

The outside cylinder of the initiator consists of two parts, 13, and 7, connected by a three-part clamp 9. Clamp 9 is held closed by means of lock 8 attached to the initiator by means of clamp assembly 10 with bracket.

The extension part of the initiator with the parachute, which prevents tipping of the canopy in ejection is dropped before the canopy is released. Levers triggering the canopy transmit action by means of the pull rod 12 and rocker assembly 17 to fork 11 and turn lock 8, releasing three-part clamp 9, thus making it possible for the extension part of the initiator with parachute to separate from the seat.

Firing of the stabilizing parachute into the air stream is [p 221] accomplished by means of converting the energy developed by burning of the cartridge powder charge into kinetic energy for firing the parachute. Cartridge PK-3M-1 is placed inside the initiator and is held by the pilot.

Technical data

1. Operating travel 600 ± 10 mm
2. Cartridge type PK-3M-1
3. Cartridge caliber. 28 mm
4. Weight of the assembly with cartridge. 6210 g
5. Unit and installation dimensions:
 - a) length. 290 ± 3
 - b) largest cross-section diameter 82 mm
 - v) attachment opening diameter. 12A3 mm
6. Firing pin protrusion. 1.4-1.8 mm
7. Locking pin release travel 22 mm
8. Locking pin pull force 20 ± 5 kg
9. Length of main spring in released position . . 36.75 mm
10. Main spring force, when compressed to 21 mm
 - length. not less than. 12.6 kg [p 222]
11. Force needed for shearing the lock's
 - stop screw. 28 ± 5 kg

Construction of initiator "215P"

Cylinder I (13, fig. 43) is a tube with outside threads on each end for attachment of bottom 19, bracket 18, cap 7, and clamp 9.

Cylinders II (14) and III (15) are tubes with an outer expansion on one end and inner expansion at the other end. The expansions form shoulders for limiting the extension of the cylinders during operation of the initiator.

Cylinder IV (16) is a tube which has an expansion with a ring shoulder on one end that stops against the inner expansion of cylinder III when cylinder IV operates.

Three-part clamp 9 is a threaded collar consisting of three parts connected by two hinges.

The clamp has a slot for screws connecting it with the lock.

Lock 8 is a lug with grooves for attachment to clamp 9 and [p 223] bracket of clamp assembly 10. Two screws are inserted into the lock with their smooth portions fitting into the grooves of clamp 9.

Clamp assembly 10 is a unit made of two half-clamps and a bracket. The clamp has two holes for attaching the igniter to the seat frame.

Insert 20 is a cylindrical insert installed in the hollow of cylinder 16 which reduces the volume of the cylinder by 30%.

The two-pin bolt is used for locking the igniter prior to firing, holding the cartridge in place, and firing when the locking pin is pulled. The bolt consists of body 6, two-pin firing pin assembly 1, main firing spring 4, head 3, and locking pin 2.

Operation of igniter "215P"

The igniter is actuated as the catapulting seat begins to move by pulling out locking pin 2 by means of a lanyard connected in the cockpit. [p 225]

When locking pin 2 is pulled, firing pin 1 by the action of main spring 4 punctures the two percussion caps which ignites the igniter and then the main charge of the firing cartridge PK-3M-1. Powder gas produced by the burning of the charge spreads through the inner chamber of the initiator. Pressed by the powder gas, cylinders 14, 15, 16 of the initiator extend until limited by the stop shoulders. At the same time, the "215P" initiator knocks out the plug installed in the rear part of the canopy and pushes the container with stabilizing parachute out into the air stream.

Insert 20 installed in the lower part of cylinder IV (pos. 16) of initiator "215P" increases powder gas pressure and the speed of cylinder 16, thus providing the necessary force for knocking out the canopy plug and pushing the parachute into the air stream.

While the canopy jettison initiators "215F" operate, the rockers which drop the canopy actuate (through a system of intermediate links) rocker 17 of initiator "215P". Turning about the axis of bracket 18, rocker 17 through pull rod 12 and fork 11 act on lock 8, 9 which holds the three-part clamp together.

Lock 8 shears the smooth parts of the screws and, while turning, releases the links of clamp 9, thus making it possible for all cylinders together with the stabilizing parachute to separate from the seat.

4. CANOPY JETTISON INITIATOR "215F"

[p 226]

General information

Initiator "215F", installed on catapulting seat "SK", is intended for forced separation of the movable part of the canopy from the seat after catapulting.

Initiators "215F" are installed on seat "SK" in pairs -- right and left.

Canopy jettison control is automatic and is accomplished by means of automatic device AD-3 which is timed to actuate after 1.5 seconds and is turned on after 50 to 100 mm of seat travel.

The canopy jettison initiator consists of cylinder 2 (fig. 44) with hollow rod 3 installed inside of it. A chamber and adapter 11 with a firing cartridge and bolt installed in it is attached to the open end of the rod.

Automatic device AD-3, operating through a system of levers and pull rods, releases the bolt pin of the "215F" initiator. The powder gas pressure produced by the burning of the cartridge (as a result of the bolt action on the cartridge) actuates the initiator rod which in turn actuates the levers of the seat beam trunnions. The beam trunnion levers, operating the rockers as they turn, release the canopy locks and the canopy separates from the seat.

Technical Data

[p 227]

1. Operating travel. 210 mm
2. Type of firing cartridge. PK-3M-1
3. Caliber of cartridge. 28 mm
4. Weight of the assembly with cartridge 3730 g
5. Unit and installation dimensions:
 - a) length between centers of attachment
holes 570 mm
 - b) largest cross-section diameter. 48 mm
 - v) diameter of attachment holes. 10.5 mm
6. Protrusion of firing pins 1.4 - 1.8 mm
7. Angle of rotation of locking pin. $30 \pm 5^\circ$
8. Locking pin turning force $5.4 \div 8$ kgcm
9. Main spring length. 36.75 mm
10. Main spring force, when compressed to the
length of 21 mm. not less than
12.6 kg
11. Force required for shearing of stop screw . . 140 ± 30 kg

Construction of canopy jettison initiator "215F"

Outside cylinder 2, (fig. 44) is a tube, one end of which is threaded for connection with bracket 1, and the other having an inner expansion; rod 3 is in contact with the inner walls of cylinder 2

Rod 3 is a tube with threads at one end for connection [p 228] with chamber 11, and with an outside expansion at the other end with holes for gas escape. The hollow inside of the rod is plugged at the piston end.

Chamber with adapter 11 is a hollow socket with adapter which has lugs at one end for attachment to the seat. The upper part of the chamber has threads for connection with bolt connector nut 10, and the adapter is threaded for connection with the rod.

Bolt of initiator "215F" is intended for locking the initiator chamber for firing, holding the firing cartridge, and firing when the locking pin is turned. The bolt consists of body 7 with firing pin assembly 6, main spring 5, head 4, and locking pin 8.

Operation of Initiator "215F"

As locking pin 8 turns, firing pin assembly 6 slips off the tooth of the locking pin and, pushed by main spring 5, simultaneously punctuates both percussion caps of cartridge PK-3M-1 which ignite the igniter and then the main charge of the cartridge. [p 230]

Powder gas created by the burning of the charge spreads through the connecting tube between the chamber and the adapter to the inside hollow of rod 3.

Gas from the inside hollow of the rod penetrates through escape holes into the space between the rod and the outside cylinder. Pushed by gas pressure, rod 3 shears stop screw 12 and moves into the inside hollow of outside cylinder 2.

The decreasing length of the initiator turns the jettison lever which releases the canopy.

5. INITIATOR "215R" FOR TIGHTENING SHOULDER HARNESS

General information

Initiator "215R" installed on the catapulting seat "SK" is intended for forceably securing the pilot to the seat at the start of catapulting.

Shoulder harness initiator "215R" (fig. 45) represents two [p 231] concentrically located telescoping cylinders, outside 9 and inside 8, equipped with a two-pin bolt, lower bracket 13 (with nozzle and pulley), and stretching spring 12 with arrester 10.

The firing cartridge installed in the hollow of the inner cylinder is held there and actuated by means of the bolt. The inner cylinder is rigidly attached to the seat's frame, while the outside cylinder is able to slide along the surface of the inner cylinder.

A cable attached to the harness tightening system passes through the pulley of the lower bracket. One end of the cable is secured to the tightening system-reel while the other is rigidly fastened to the frame of seat "SK".

Pressing the trigger levers on the seat arms actuates the entire trigger system.

Trigger lever action is transmitted by means of a cable to the rocker (installed on the end shaft of the bolt locking pin) which, turning the locking pin of the initiator, actuates the bolt.

Technical data

[p 232]

1. Operating travel of the initiator 110 mm
2. Type of cartridge PK-3M-1
3. Cartridge caliber 28 mm
4. Weight of the structure with the cartridge. . 880 g
5. Unit and installation dimensions
 - a) length 363 ± 6 mm
 - b) largest cross-section diameter. 40 mm
 - v) outside cylinder diameter. $38X_3$ mm
 - g) size of internal cylinder attachment
thread. 3M36 x 1.5
6. Firing pin protrusion 1.4 - 1.8 mm
7. Angle of rotation of locking pin. $30^\circ \pm 5$
8. Locking pin turning force 5.4 ± 8 kgcm
9. Length of main spring in released position. . 36.75 mm
10. Main spring force, when compressed to length
of not less than 21 mm not less than
12.6 kg
11. Diameter of the nozzle bleed opening. $2A_3$ mm

Construction of initiator "215R"

Outside cylinder 9 is a tube which has an expansion with internal threads for connection with lower bracket 13.

Inside cylinder 8 is a tube with an externally threaded [p 233] expansion for connection with the bolt. The inside hollow of the tube serves for installation of the firing cartridge, spring 12, and arrester 10.

Bracket 13 - represents a socket with threads for connection to cylinder 9 and a bracket for the axle of pulley 14. The bottom part of bracket 13 has an opening for a nozzle.

Bolt of initiator "215R" is identical in regard to its purpose and construction to the bolt described in the section: "Bolt of initiator "215F".

Arrester 10 is an insert with holes and acts as a grate preventing the nipple from becoming clogged and also serves as a support for spring 12.

Operation of initiator "215R"

Operation of the seat arm triggering levers by the pilot causes actuation of the harness tightening initiator which forceably fastens the pilot to the seat. As locking pin 5 turns, the bolt firing pin 3 slips from the tooth of the pin and, pushed by main spring 2, simultaneously punctures the two percussion caps of firing cartridge PK-3M-1 which ignite the igniter and then the main charge of the cartridge. Pressure of powder gas produced by the burning of the charge blows opens the cartridge and gas spreads through the entire inner hollow of the initiator through slits and openings of the conical part of arrester 10.

Pressed by the gas, cylinder 9 moves downward and the pulley on lower bracket 13, pressing against the cable which passes over it, actuates the fastening system. Excess gas produced by the burning of the charge is released from the inside hollow of the initiator through the nozzle in bracket 13.

CHAPTER VIII

AIRCRAFT ARMOR

I. BRIEF INFORMATION

The armor serves to protect the pilot from being hit and for protection of the firing cartridges of firing mechanisms TSM-2500-38 and "215P".

Pilot protection consists of armor plate 1 (fig. 46) installed in front on frame #6 and bullet-proof glass 2 installed under the forward part of the canopy. For protection of the pilot's head from the rear and the cartridges of the firing mechanisms a bullet-proof headrest 3 and armor plate 4 are used.

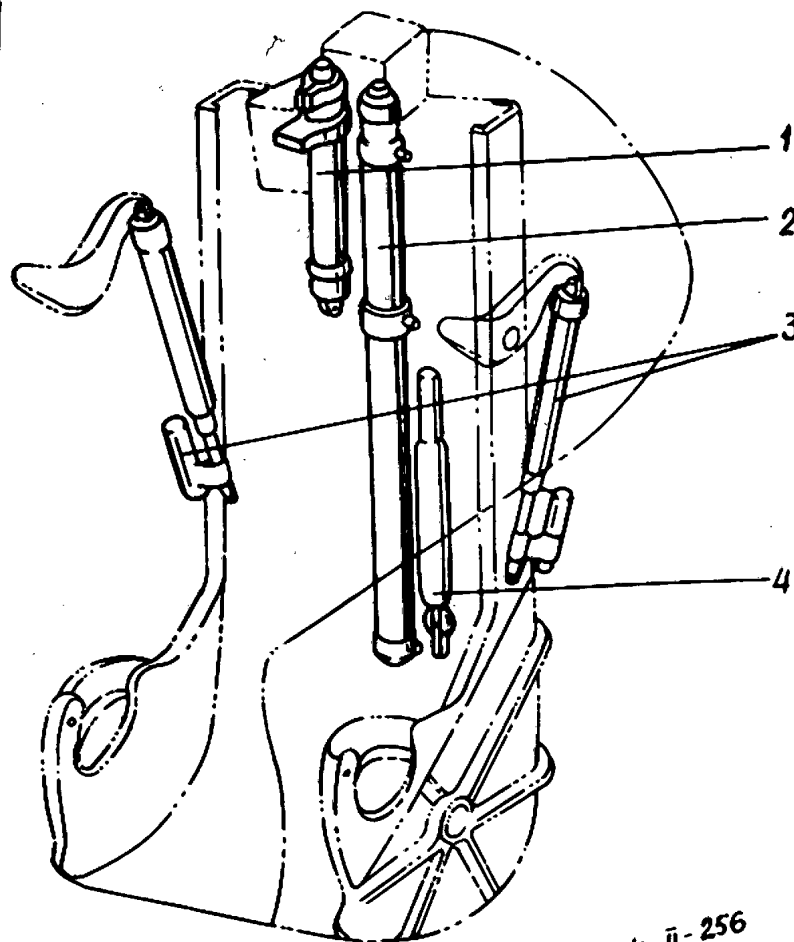
Armor plate 4 with a thickness of 16 mm and dimensions of 552 x 690 mm, protecting the pilot as well as the firing cartridge and bolt of the firing mechanisms, is installed on fuselage frame 11 and is attached by special bolts $\varnothing$ 10 mm gaskets.

Armor plate 1, 490 x 538 and 10 mm thick, is fastened to fuselage frame #6 by $\varnothing$ 6 and $\varnothing$ 8 mm bolts with gaskets.

The headrest armor protector 3 is a round plate 228 x 235 mm, 16 mm thick. This armor protector is installed on seat "SK" and is attached to the frame of the seat by special bolts $\varnothing$ 12 mm.

Bullet-proof glass 2, 62.5 mm thick protecting the pilot [p 238] from the front, is made of two silicate glass sheets 5 and 25 mm thick, respectively, glued together by special "Butafol" film, and one organic glass sheet 22 mm thick glued to the silicate glass by an "MMA" film.

The bullet-proof glass is mounted in a steel frame attached to the sight bracket by $\varnothing$ 8, 10, and 14 mm bolts, and has the organic glass part facing toward the cockpit.

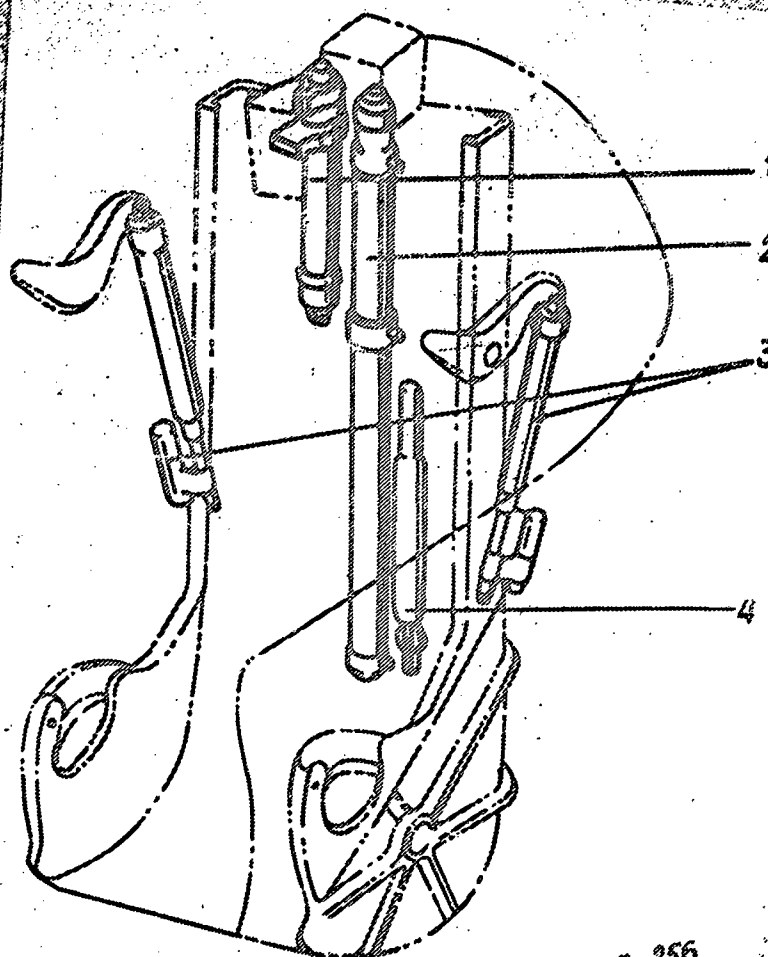


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Фиг. 41. Схема расположения пиромеханизмов катапультируемого сиденья "СК".

1-пиромеханизм "215П" выстрела стабилизирующего парашюта; 2-телескопический стреляющий механизм ТСМ-2500-38 катапультирования сиденья "СК"; 3-пиромеханизм "215П" сброса фонаря; 4-пиромеханизм "215П" притяга плечевых ремней.

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74-II-256

Fig. 41. Diagram of location of initiators for ejection seat "SK"

- 1-initiator "215P" for ejection of stabilizing parachute;
 2-telescoping firing mechanism TSM-2500-38 for ejection
 seat "SK"; 3-initiator "215P" for canopy jettison;
 4-initiator "215R" for tightening shoulder harness.

парашюта; 2-телескопический стреляющий механизм

TSM-2500-38 катапультирования сиденья "СК"; 3-пиро-

механизм "215P" сброса фонаря; 4-пиромеханизм "215P"

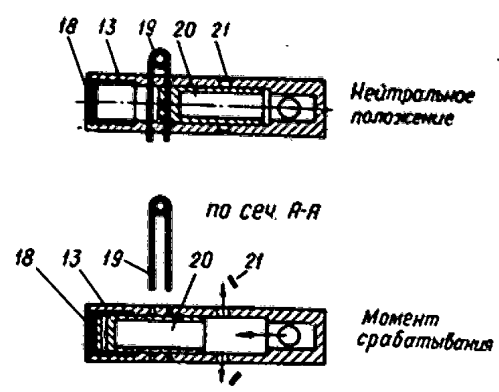
притягива плечевых ремней.

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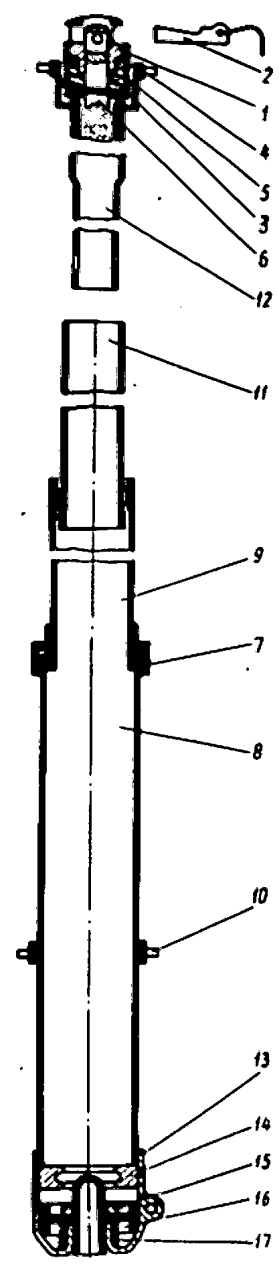
S-E-C-R-E-T

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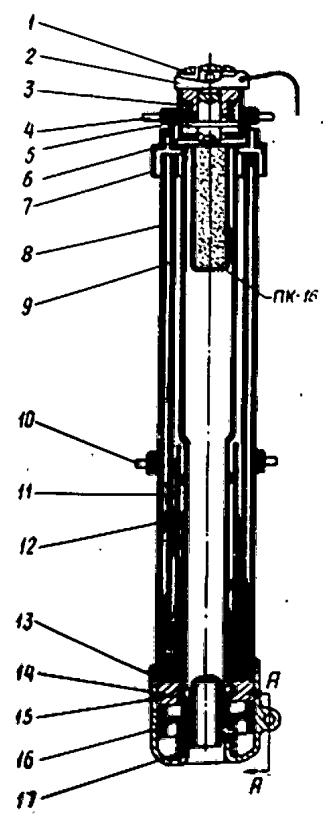
Схема работы срабатывающего механизма (по сеч. А-А)



Взаиморасположение частей ТСМ-2500 при катapultировании



Исходное положение ТСМ-2500

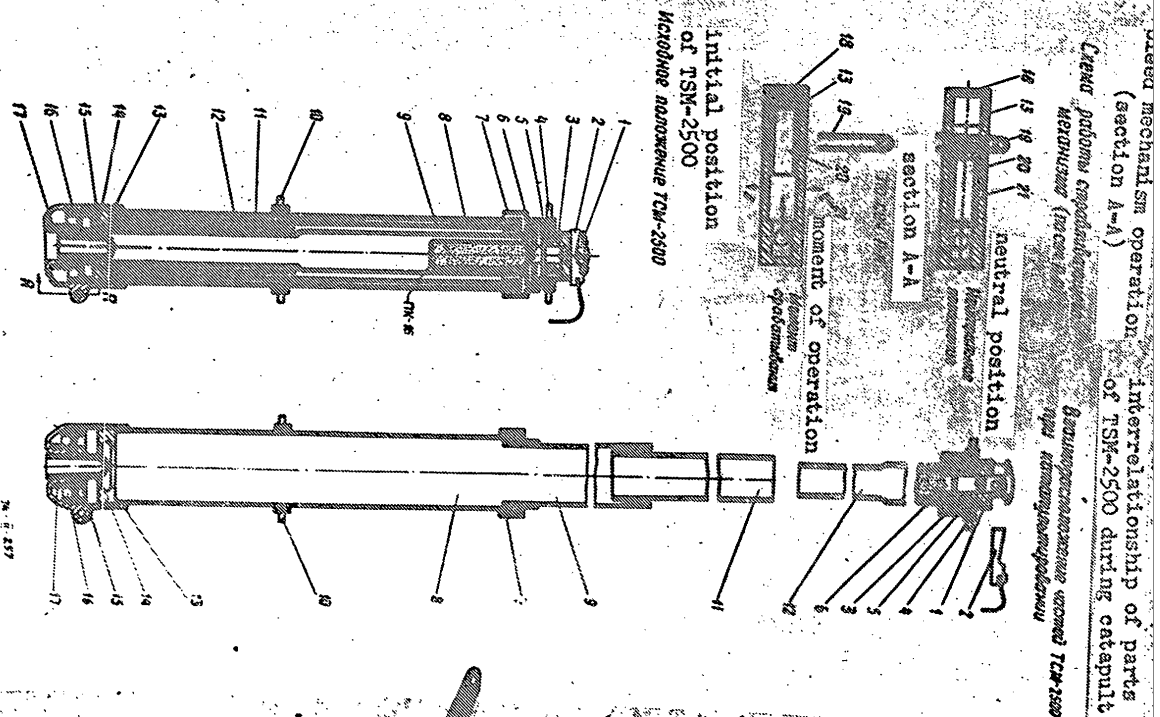


74-А 257

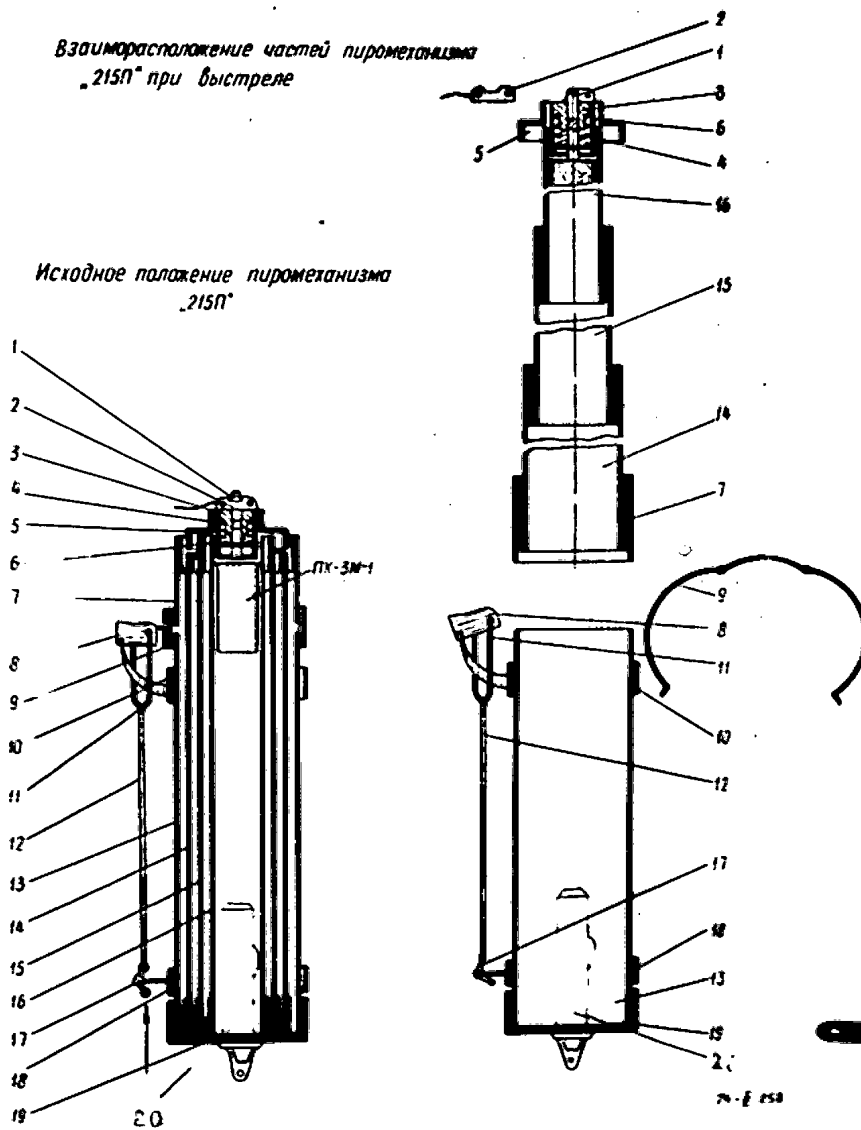
Фиг. 42. Принципиальная схема действия телескопического стреляющего механизма ТСМ-2500-38.

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Fig. 42. Schematic diagram of operation of telescoping firing mechanism TSM-2500 50X1-HUM
1-head; 2-locking pin; 3-main spring; 4-upper clamp; 5-bolt body; 6-two-pin firing pin assembly; 7-socket; 8-outside cylinder; 9-middle cylinder I; 10-lower clamp; 11-middle cylinder II; 12-inside cylinder; 13-ball lock housing; 16-ball lock plunger; 17-lock spring; 18-nut; 19-bleed device spring lock; 20-bleed mechanism plunger; 21-diaphragm.



См. 42. Принципиальная схема действия телескопического устройства TSM-2500-38.



СЛГ. 43. Принципиальная схема действия пиромеханизма „215П“.

- 1-двухкопийный ударник; 2-соевая чека затвора;
- 3-голова затвора; 4-боевая пружина затвора;
- 5-оседлательная втулка; 6-корпус двухкопийного затвора; 7-носик; 8-завлок; 9-трехзванный хомут; 10-оседлательный хомут; 11-серьга; 12-дуга; 13-цилиндр I; 14-цилиндр II; 15-цилиндр III; 16-цилиндр IV; 17-начало; 18-контрплат; 19-дно; 20-выстрел.

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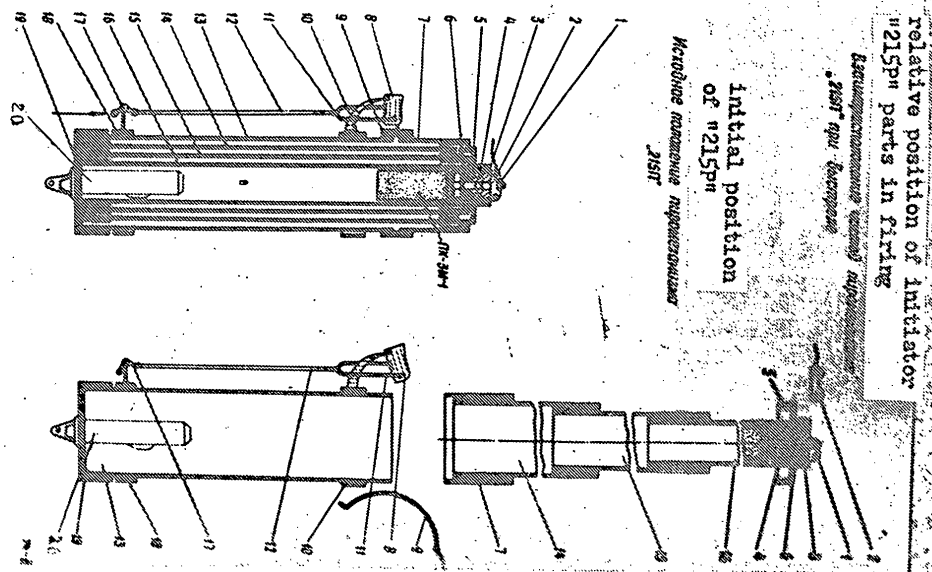


Fig. 43. Schematic diagram of operation of initiator "215P"

- 1-two-pin firing pin assembly; 2-locking pin; 3-three-part clamp; 4-main spring; 5-connecting bushing; 6-bolt body; 7-cap; 8-lock; 9-trilinear clamp; 10-clamp assembly; 11-fork; 12-pull rod; 13-cylinder I; 14-cylinder II; 15-cylinder III; 16-cylinder IV; 17-rocker; 18-bracket; 19-bottom; 20-insert.

1-двапалочный ударник; 2-защелка; 3-трехчастный зажим; 4-основная пружина; 5-соединительная втулка; 6-тело болта; 7-крышка; 8-замок; 9-трехзвенный зажим; 10-зажимная сборка; 11-вилка; 12-тяговая штанга; 13-цилиндр I; 14-цилиндр II; 15-цилиндр III; 16-цилиндр IV; 17-рычаг; 18-кронштейн; 19-дно; 20-вставка.

Исходное положение
пиромеханизма "215Ф"

Взаиморасположение частей
пиромеханизма "215Ф" при
срабатывании

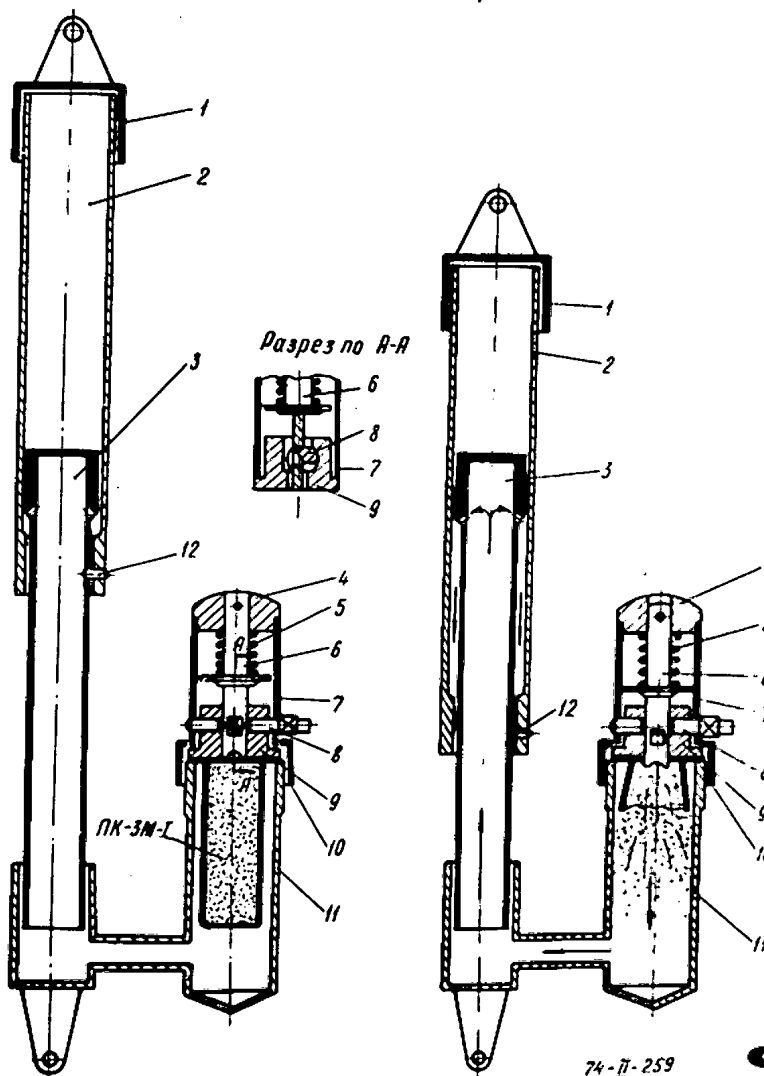


Рис. 44. Принципиальная схема действия
пиромеханизма "215Ф"

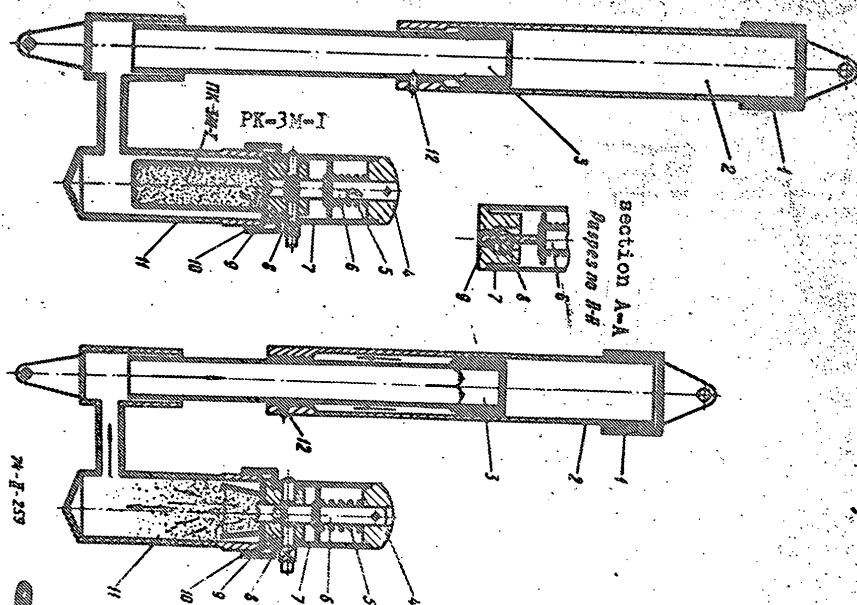
- 1-кронштейн; 2-цилиндр; 3-шток; 4-голова
затвора; 5-пружина затвора; 6-ударник двух-
бойковый; 7-корпус затвора; 8-боевая чека
затвора; 9-выкладной затвора; 10-накидная гайка;
11-камера с переходником; 12-отпорный пистолет;

50X1-HUM

Fig. 44. Schematic diagram of operation of initiator "215F"

50X1-HUM

- 1-bracket; 2-cylinder; 3-rod; 4-bolt head; 5-bolt spring; 6-two-pin firing pin assembly; 7-bolt housing; 8-locking pin; 9-bolt insert; 10-connecting nut; 11-chamber with adapter; 12-arresting screw.



Initial position of initiator "215F"
исходное положение инициатора "215F"
Relative position of "215F" parts during canopy jettison
относительное положение частей инициатора "215F" при сбросе парашюта

1-корпус; 2-цилиндр; 3-шток; 4-головка болта; 5-пружина болта; 6-двухконечная игла; 7-корпус болта; 8-защелка; 9-вставка болта; 10-соединительная гайка; 11-камера с адаптером; 12-защелка.

Исходное положение
пиромеханизма "215Ф"

Взаиморасположение частей
пиромеханизма "215Ф" при
срабатывании

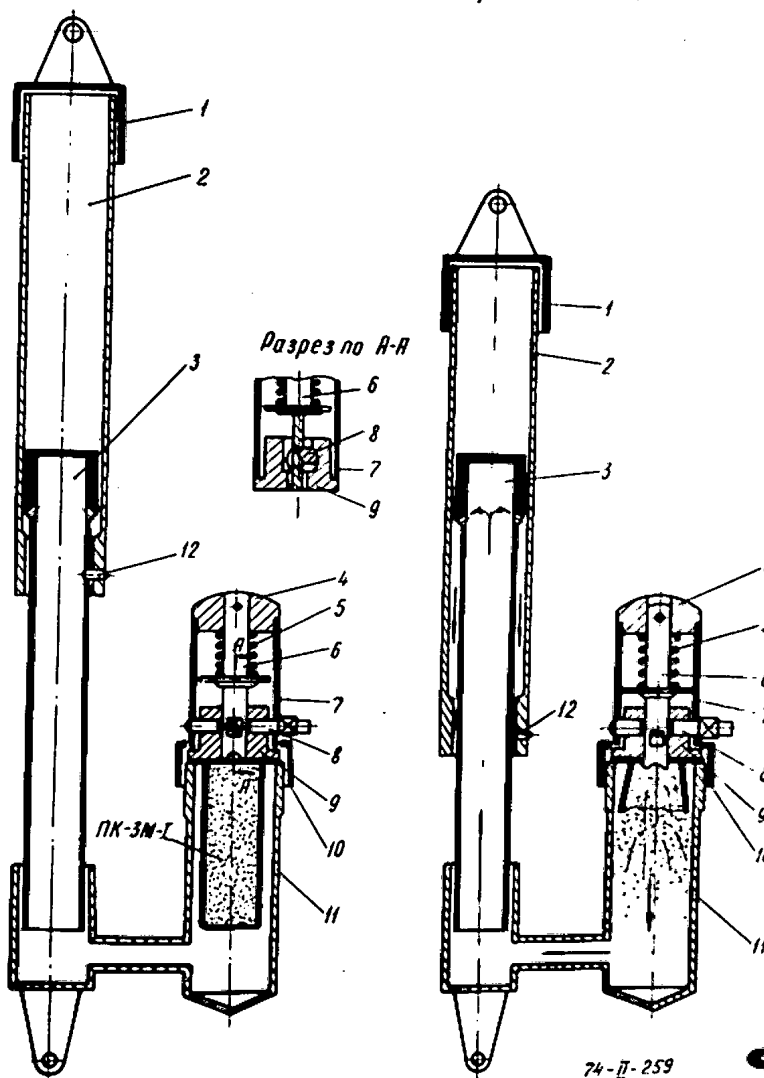


Рис. 44. Принципиальная схема действия
пиромеханизма "215Ф"

1-кронштейн; 2-цилиндр; 3-шток; 4-головка
затвора; 5-пружина затвора; 6-ударник двух-
бойковый; 7-корпус затвора; 8-боевая чека
затвора; 9-выкладчик затвора; 10-нажимная гайка;
11-камера с переходником; 12-сторонный пинт;

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50X1-HUM

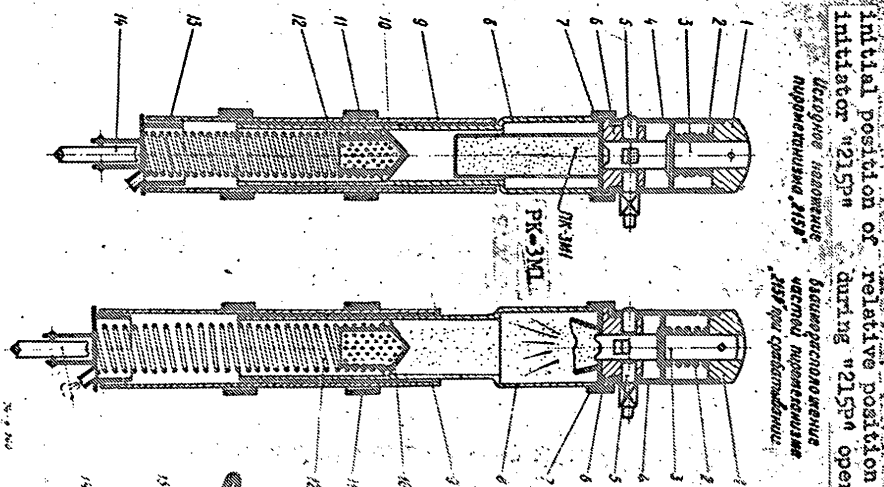


Fig. 45. Schematic diagram of the operation of initiator "215R"

1-two-pin bolt head; 2-main bolt spring; 3-two-pin firing pin; 4-bolt body; 5-locking pin; 6-insert; 7-connecting nut; 8-inside cylinder; 9-outside cylinder; 10-arrester; 11-initiator attachment clamp; 12-stretching spring; 13-lower bracket; 14-pulley.

1-головка двухпального затвора; 2-основная пружина затвора; 3-двухпальный пистолет; 4-корпус затвора; 5-защелка; 6-вставка; 7-соединительная гайка; 8-внутренний цилиндр; 9-наружный цилиндр; 10-остановитель; 11-крепление инициатора; 12-растягивающая пружина; 13-нижняя скобка; 14-шкив.

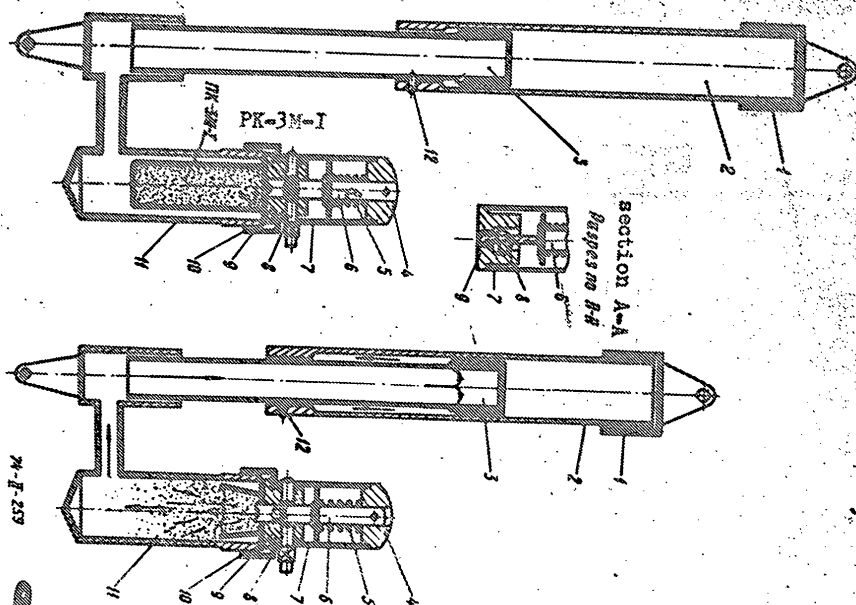
рис. 45. Принципиальная схема действия инициатора "215Р".

Fig. 44. Schematic diagram of operation of initiator "215F"

1-bracket; 2-cylinder; 3-rod; 4-bolt head; 5-bolt spring; 6-two-pin firing pin assembly; 7-bolt housing; 8-locking pin; 9-bolt insert; 10-connecting nut; 11-chamber with adapter; 12-arresting screw.

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Initial position of initiator "215F"
исходное положение инициатора "215Ф"

Relative position of "215F" parts during canopy jettison
относительное положение частей инициатора "215Ф" при сбросе парашюта

Fig. 44. Schematic diagram of operation of initiator "215F"

1-bracket; 2-cylinder; 3-rod; 4-bolt head; 5-bolt spring; 6-two-pin firing pin assembly; 7-bolt housing; 8-locking pin; 9-bolt insert; 10-connecting nut; 11-chamber with adapter; 12-arresting screw.

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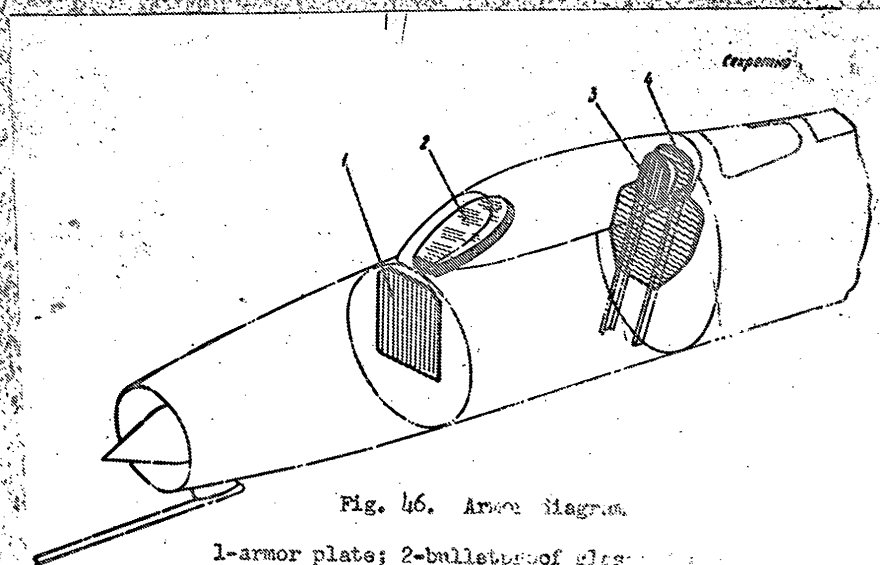


Fig. 46. Схема бронирования,
1- бронеплита, 2- бронестекло, 3- бронестекло,
4- бронеплита.

Appendix No 1

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Specifications of Ready-Made Electrical Parts
and Electrified Units Used in Aircraft Armament Apparatus

Item No.	Pos. in elec. circuit	Name	Type	Quantity	Location
1	2	3	4	5	6
1	1P	"Sight, Sight Heating" circuit breaker	AZS-20	1	Cockpit, right front elec panel
2	2P	"Sight" circuit breaker	AZS-10	1	Same as above
3	3P	PO-500A relay for missile power supply	TKYe-52PD	1	Lower equip hatch Radio relay box, frame 8-9, right side
4	4P	Filter	F-14A	1	Cockpit, frames 10-11, right side
5	5P	Distributor box (unit #5)	ASP-5ND	1	Upper special equip hatch, frames 5-6, left side
6	6P	Zero gyro amplifier (unit #4)	ASP-5ND	1	Same as above
7	7P	Automatic Device for introduction of altitude (unit #6)	ASP-5ND	1	Upper special equip hatch, frames 5-6, in aircraft's axis of symmetry
8	8P	Damping button 20LKS		1	Cockpit, control stick handle
9	9P	Electronic relay unit (unit #8)	ASP-5ND	1	Upper special equip hatch, frames 5-6, right side

1	2	3	4	5	6	[p 240]
10	10P	Computer (unit #2)	ASP-5ND	1	Upper special equip hatch, frames 3-4, left side	
11	11P	Zero gyro (unit #3)	ASP-5ND	1	Upper special equip hatch, frames 2-2A, in aircraft's axis of symmetry	
12	12P	Sight head (unit #1)	ASP-5ND	1	Cockpit, frame 7b, above inst panel	
13	13P	Voltage sta- bilizer (unit #9)	SM-4 (of set ASP-5ND)	1	Cockpit, frames 6-7, on floor	
14	14P	Fuse in homing mis. a-c circuit	SP-5	1	Radio relay box, frames 8-9, under cockpit floor	
15	15P	Manual range intro. pot	ASP-5ND	1	Cockpit, throttle control quadrant	
16	16P	Sight selec- tor switch panel	ASP-5ND	1	Cockpit, unit #1 above inst panel	
17	17P	"NR, Missile, Rocket, FKP" circuit breaker	AZS-5	1	Cockpit, right rear elec panel	
18	18P	Fire control button	204KS	1	Aircraft control stick	
19	19P	"FKP" circuit breaker	AZS-5	1	Cockpit, right front elec panel	
20	24P	Operating mode switch for range-only radar and "Rocket, Gun- Missile" firing circuit	VT36020060P	1	Cockpit, vertical part of left panel	
21	25P	"Gun" circuit breaker	AZS-10	1	Cockpit, right front elec panel	[p 241]

1	2	3	4	5	6
22	26P	Gun firing and rocket launch control relay	TKYe-21PD	1	Relay box behind pilot's seat, on left
23	27P	Electrical gun trigger	-	1	Gun
24	28P	Gun firing and FKP circuit relay	TKYe-52PD	1	Relay box behind instrument panel
25	37P	Gun ready signal light	SLTs-51 (red)	1	Instrument panel, center board
26	38P	Gun ready signal relay	TKYe-21PD	1	Relay box behind instrument panel
27	39P	Gun reload button	5KS	1	Upper left part of inst panel
28	40P	Gun reload electro-pneumatic valve	EK-48	1	Frames 14-15, lower right side
29	41P	Rocket and FKP circuits relay	TKYe-52PD	1	Relay box behind pilot's seat
30	42P	Gun camera	SSh45-1-100-OS	1	Cockpit, on sight head
31	43P	Time mechanism	VM-2	1	Cockpit, to right of sight head
32	44P	SIV-52 power supply	SIV-52	1	Cockpit, behind pilot's seat, on right
33	46P	"SIV" circuit breaker	AZS-5	1	Cockpit, right front elec panel
34	1B	"Tank, Rocket, APU Attachment Signal" circuit breaker	AZS-5	1	Cockpit, right rear elec panel

1	2	3	4	5	6
35	5B	Tank attach. lock	BDZ-56-Ye	1	Fuselage pylon, frames #17-18
36	7B	Tank attach. signal light	SLTs-51 (green)	1	Cockpit, center board
37	8B	Wing pylon	BDZ-60-21U	1	Right wing
38	9B	"Tank, Rocket, APU Emer. Jet. Emergency Mis-sile Launch" circuit breaker	AZS-20	1	Cockpit, right rear elec panel
39	10B	Tank jettison button	5KS	1	Left side of instrument panel
40	11B	Wing pylon	BDZ-60-21U	1	Left wing
41	12B	PUS null position light	SLTs-51 (green)	1	Cockpit, right front elec panel
42	13B	PUS null position light	SLTs-51 (green)	1	Same as above
43	14B	"Rocket" circuit breaker	AZS-10	1	Cockpit, right front elec panel
44	15B	Rocket salvo select. switch	VTZ-602020SP	1	Left panel, vertical part
45	16B	Rocket launch control instr.	PUS-36D	1	Left wing, rib tips 14-15
46	17B	Rocket launch control instr.	PUS-36D	1	Right wing, rib tips 14-15
47	19B	Homing missile signal volume control	SPO-0.5-VT-33K-Sh13	1	Left panel
48	20B	Rocket and mis-sile launch-LG blocking relay	TKYe-53PD	1	Relay box, frames 11-12, left side
49	21B	Overload signal relay	TKYe-21PD	1	Relay box behind instrument panel

1	2	3	4	5	6
50	22B	Missile emer. launch button	204KS	1	Instrument panel
51	23B	Rocket, APU- missile emer. jet. button	205KS	1	Left upper part of inst panel
52	24B	Rocket, APU left wing attachment signal light	SLTs-51 (green)	1	Instrument panel, [p 244] center board
53	25B	Rocket, APU right wing attachment signal light	SLTs-51 (green)	1	same as above
54	26B	Altitude sig- nalling device	VS-14500	1	Frames 2-2a in equip hatch, left
55	27B	Overload signal light	SLTs-51 (red)	1	Above inst panel, on sight bracket
56	28B	"Missile Warning" cir- cuit breaker	AZS-20	1	Cockpit, right front elec panel
57	29B	"Missile Filament" circuit breaker	AZS-10	1	same as above
58	30B	"Missile Launching" circuit breaker	AZS-10	1	same as above
59	31B	Left missile attachment signal light	SLTs-51 (green)	1	Instrument panel, upper right board
60	32B	Right missile attachment signal light	SLTs-51 (green)	1	same as above
61	33B	"Salvo-Single" missile launch switch	87K	1	Instrument panel, upper right board

1	2	3	4	5	6
62	34B	Overload sig. circuit relay	TKYe-21PD	1	Relay box behind pilot's seat, on left
63	35B	Overload mechanism	MP-28A	1	Frames 11-12, back fairing
64	36B	Separate mis- sile launch switch	2PPN-45	1	Instrument panel, right front board p 245
65	37B	Missile launch circuit relay	TKYe-52PD	1	Relay box behind pilot's seat, on left
66	40B	APU, UB attach. lock	DZ-57	1	Pylon, left wing
67	41B	APU, UB attach. lock	DZ-57	1	Pylon, right wing
68	6R	"SRD" circuit breaker	AZS-5	1	Cockpit, right front elec panel
69	25R	"Withdraw from Attack" signal light	SLTs-51 (red)	1	Above inst panel on sight bracket
70	26R	Permissible range signal light	SLTs-51 (green)	1	same as above
71	24S	Light condition monitor relay	TKYe-56PD	1	Relay box behind instrument panel
72	17E	High-current apparatus cut-in relay	TKD-203DA	1	Cockpit, frames 6-7, right side
73	33E	High-current apparatus cut-out relay	TKYe-53PD	1	Cockpit, frames 6-7, right side p 246
74	15R	ASP, SIV, mis. power supply converter	PO-500A	1	Upper equip hatch, frames #4-5, right side

1	2	3	4	5	6
75	47R	Fuse	SP-5	1	Relay box, frames #8-9, right side, bottom of fuselage
76	48R	SIV actuation relay	TKYe-52PD	1	same as above
77	20R	Fuse	SP-5	1	same as above

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1. Brief information

APPENDIX NO. 1

Specifications of ready-made electrical parts and
electrified units used in aircraft armament apparatus

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